Heating and Ventilating

For Engineers and Contractors Controlling the Design, Specification, Installation and Maintenance of Heating, Ventilating and Air Conditioning

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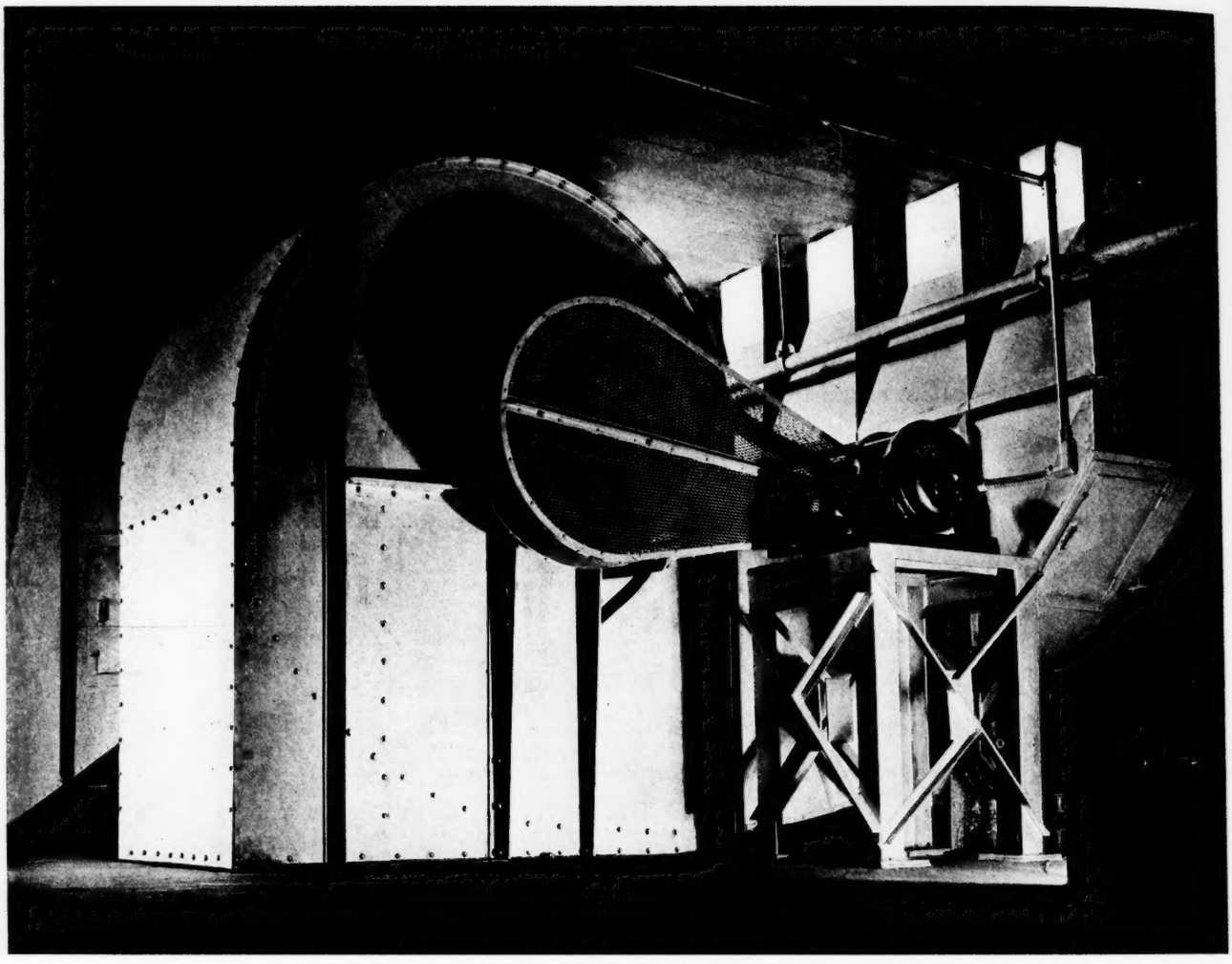


". . . inevitably with the development of air conditioning and its simplification and consequent cheapening, every heating job, in my mind, will eventually be an air conditioning job."

Construction of a Simple Psychrometric Chart

By A. E. Beals

To facilitate the thermal calculations required for solving problems in connection with air conditioning is the purpose of psychrometric charts, a number of different forms of which have been designed.

The better known and more widely used charts are constructed with reference to rectangular axes, using weights of moisture vapor per pound of air as ordinates and dry bulb temperatures as abscissas.

Of these variables the weight of vapor is a tangible quantity having a concrete value, while the dry bulb temperature is merely one of two coordinating indications of a condition having no tangible value as a unit. Dry bulb temperature is purely a secondary variable.

As a result, heat content, which does have tangible values and is one of the two primary variables which affect atmospheric conditions, can not be determined directly upon such charts. An auxiliary curve thus becomes necessary.

It is proposed to construct a psychrometric chart which shall be simple, easily read, and as comprehensive as possible of all variable values ordinarily used in air conditioning calculations.

The ordinates will be weights of water vapor mixed with 1 lb. of pure air. The abscissas will be the heat in 1 lb. of pure air, reckoned from 0° F., plus the latent heat of the water vapor present. In steam tables the weights of water vapor are given in pounds per cubic foot, but following conventional usage in air calculations, the water vapor weights in this instance will be taken in grains per pound of air.

At an atmospheric pressure of 14.7 lb. per sq. in., absolute, and 32° temperature, 1 cu. ft. of pure air weighs 0.080728 lb. and, therefore, the specific volume is 12.3872 cu. ft. per lb.

The fundamental equation expressing the relations of pressure, volume and temperature of a perfect gas is

$$\frac{p'v'}{T'} = \frac{p''v''}{T''},$$

in which p′, v′ and T′ represent the known absolute pressure per square inch, the volume in cubic feet, and the absolute temperature, respectively. Therefore, the expression

$$\frac{pv}{T} = \frac{14.7 \times 12.3872}{459.6 + 32} = 0.3704$$

is true for any relation of pressure, volume and temperature of pure air. From this equation, the temperature and pressure being known, the volume may be calculated.

The chart which it is proposed to construct will be based upon 14.7 lb. per sq. in. absolute pressure, and later it will be shown how the different values will be modified to suit any other pressure condition.

As a specific example of how the values of the different variables are determined, let 70° temperature be chosen as the one known variable.

The Marks and Davis steam tables give the saturated pressure corresponding to 70° as 0.3626 lb. per sq. in. This is that portion of the total pressure exerted by the vapor, the balance, or 14.7 lb. — 0.3626 lb. = 14.3374 lb. per sq. in., being due to the air tension.

The absolute temperature will be 459.6° + 70° = 529.6° and, therefore,

$$\frac{14.3374 \times v}{529.6} = 0.3704$$

will express the volume in cubic feet occupied by 1 lb. of air. Solving for v, the volume of air under the assumed conditions of temperature and pressure will be 13.682 cu. ft.

If saturated, this volume will also be occupied by the maximum possible weight of vapor corresponding to the assumed temperature. Again, from the steam tables, it is found that at maximum density vapor at 70° temperature weighs 0.001148 lb. per cu. ft. Accordingly, the maximum weight of vapor possible to exist in 13.682 cu. ft. will be 0.0157069 lb. or 109.95 gr. Hence, the expression, "1 lb. of air at 70°, saturated, contains 109.95 gr. of moisture". This is 100% relative humidity.

What is the amount of heat, above 0°, contained in 1 lb. of air, at 70° temperature and mixed with 109.95 gr. of moisture?

Taking the value of 0.2411 as the average specific heat of pure air, the total heat

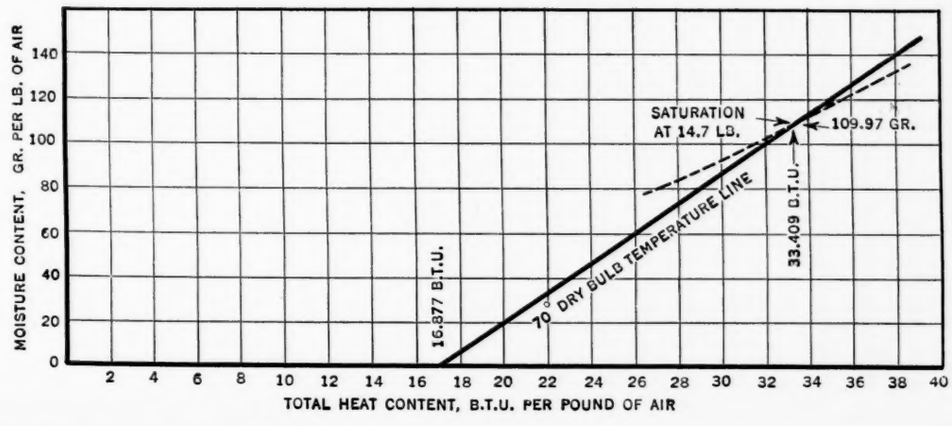
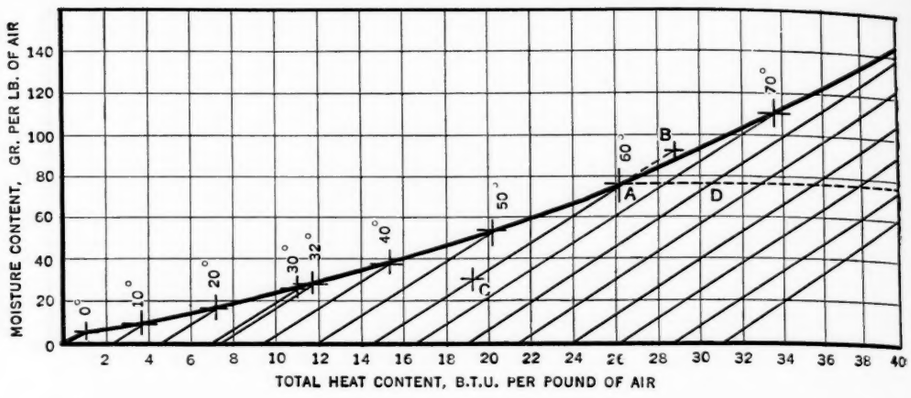


Fig. 1

Fig. 2



of the air will be (70 — 0) × 0.2411 = 16.877 B.t.u. Now consider that 109.95 gr. or 0.0157069 lb. of water at 70° is placed in contact with the air. The temperatures of the two bodies being equal, there will be no transfer of heat between them. However, since there is no vapor occupying the space, the effect on the water will be the same as placing it in a vacuum, and it will immediately begin to evaporate, with the resulting tendency to lower its temperature.

Referring to the steam tables, it is found that 1052.3 B.t.u. are required to evaporate 1 lb. of water at 70° temperature into vapor at the same temperature. Unless this amount of heat is supplied from outside sources, it will be abstracted from the surrounding air, with a consequent lowering of temperature.

Therefore, to maintain the stipulated temperature of 70° it will be necessary to supply 0.0157069 × 1052.3 = 16.582 B.t.u. of heat from an outside source.

The total heat in 1 lb. of air and 109.95 gr. of moisture then will be 16.877 + 16.582 = 33.405 B.t.u.

From the above it is evident that this 70° line of equal temperatures must touch the horizontal axis at 16.877 B.t.u. from the vertical axis, and pass through the coordinate point of 109.95 gr. of moisture and 33.405 B.t.u. of heat.

This line of equal temperatures is also a straight line because a definite amount of heat is required to evaporate a definite amount of water; therefore, equal increments of vapor require equal increments of heat.

It will be found that the 70° temperature line may be plotted upon this chart by the equation

Gr. Moisture = 6.652 × (Heat in mixture in B.t.u.) — 112.2658.

The equal temperature lines are not quite parallel, although nearly so, the tangent of the angle of inclination with the horizontal axis for the line of 32° being 6.521 and the tangent of the 100° line being 6.76. This makes a difference of 18 min. of angularity in this range. Therefore, if there were any occasion for it, the development of a different equation would be required for each degree of equal temperature lines.

All equal temperature lines are indicated by the dry bulb thermometer and are therefore dry bulb temperature lines.

The location and extent of the dry bulb temperature line of 70° are shown by Fig. 1. From this the total heat content may be read for any amount of moisture content, ranging from nothing to saturation, or the maximum amount possible to be present, at 70° temperature and 14.7 lb. absolute pressure per square inch.

In like manner, heat content and maximum vapor content values may be determined for all temperatures within the scope of the proposed chart, and their coordinate locations thereon will determine the curve of saturation.

Thus, with the saturation curve, or curve of maximum vapor content, and the dry bulb temperature lines located, the heat content of 1 lb. of air at any temperature and mixed with any amount of vapor may be read directly from the chart.

The position and direction of dry bulb temperature lines are shown in Fig. 2.

It will be noted that these lines may be constructed without reference to any variables other than moisture and heat contents. They extend indefinitely, and maintain a constant location and direction irrespective of the air tension.

Each temperature line starts from the horizontal axis at a distance from the origin equal to the temperature multiplied by the constant 0.2411. Therefore, they are equally spaced along the base line.

The angle subtended between any temperature line and the horizontal axis is determined by dividing 7000 by the latent heat of evaporation per pound of vapor for the particular temperature. The numerical value thus found is the ratio of the number of grains of moisture per B.t.u. of latent heat contained in the vapor at that temperature. Therefore, all dry bulb temperature lines make slightly different angles with the horizontal axis.

The upper boundary of these lines is determined by the curve of saturation which, in turn, is a function of the barometric pressure, or of whatever total pressure to which the mixture of air and vapor may be subjected.

It must be borne in mind that the partial pressure of the vapor, if at the saturation point, remains constant under constant temperature, regardless of the total pressure of the mixture.

The indicated upper boundary of these lines, as shown on Fig. 2, is that due to a barometric pressure of 29.92 in. of mercury, or 14.7 lb. per sq. in. At any other total pressure, the length of these lines will be inversely proportional to the partial pressure of the air due to the particular temperature and total pressure.

For instance, at 60° temperature and saturation, the partial pressure of the vapor is 0.52 in. of mercury, or 0.2562 lb. absolute pressure per square inch. At 29.92 in. of mercury, or 14.7 lb. pressure, 1 lb. of air is mixed with 77.359 gr. of moisture when saturated. At 25 in.

of mercury, 1 lb. of air at 60° saturated is mixed with

$$77.359 \times \frac{29.92 - 0.52}{25.00 - 0.52} = 92.906 \text{ gr. of moisture.}$$

At 20 lb. gauge pressure, or at 34.7 lb. absolute, 1 lb. of air at 60° will become saturated with

$$77.359 \times \frac{14.7 - 0.2562}{34.7 - 0.2562} = 32.44 \text{ gr. of moisture.}$$

The locations of the curves of saturation for these three pressures, in reference to the 60° dry bulb temperature line, are indicated upon Fig. 2 by the points A, B and C, respectively.

Although the dry bulb temperature lines remain fixed, the wet bulb temperature lines vary in accordance with the location of the saturation curve to correspond to various total pressures.

The temperature of any point on the saturation curve is also the dewpoint temperature for 1 lb. of air at any temperature when mixed with the corresponding amount of vapor. If heat is added to 1 lb. of air, starting under any dewpoint temperature condition, the water vapor immediately assumes a superheated state, and the temperature and volume of the mixture increase in direct proportion to the heat added. The resulting temperatures are read along the horizontal line passing through the given dewpoint.

Conversely, if heat is then withdrawn from the mixture, its temperature and volume will decrease proportionately until the dewpoint is reached. At this point the maximum amount of vapor possible to exist with 1 lb. of air, under the given temperature and pressure conditions, is attained.

Referring to Fig. 2, 60° is the dewpoint of condition D, for instance, on the 80° line. In other words, it is that temperature at which 1 lb. of air at 80° temperature and mixed with 77.359 gr. of vapor becomes saturated by the extraction of heat.

Any further withdrawal of heat will be attended by a condensation of part of the vapor, thus reducing the moisture content. From the dewpoint down the change of temperature, due to the continued withdrawal of heat, will follow along the saturation curve.

Between 60° saturation and point D on the 80° line, Fig. 2, the mixture of air and vapor follows the law of perfect gases and, therefore, the equation

$$\frac{p'v'}{T'} = \frac{p''v''}{T''}$$

expresses the relations between the pressures, volumes and temperatures. Below 60° saturated, this expression does not hold true.

The lines of equal temperatures having been located and drawn upon the chart, and the maximum moisture content in grains of vapor per pound of air having been determined for the respective temperatures, the curve of saturation is thereby outlined.

As the dry bulb and wet bulb thermometers register equal temperatures at saturation, all lines of equal wet bulb temperatures must join the intersection of the dry bulb temperature lines with the saturation curve.

All wet bulb temperature lines upon the chart will be vertical and at right angles to the horizontal axis, in accordance with the fourth principle of evaporation.

Since the wet bulb temperature of the air depends on the total of the sensible and latent heat in the air, the lines of constant wet bulb temperatures coincide with the lines of constant total heat content and, consequently, are vertical lines extending from the horizontal axis to the curve of saturation.

Since the dry and wet bulb thermometers register equal temperatures at saturation, it will be evident that these vertical wet bulb temperature lines must pass through the point of intersection of the saturation curve with the dry bulb line of the same temperature.

Therefore, referring to Fig. 3, the vertical lines W are the lines of equal wet bulb temperatures in relation to the corresponding lines of equal dry bulb temperatures D.

The point of intersection of a dry bulb temperature line with any wet bulb temperature line shows at once the total heat content and the moisture content for the particular condition indicated.

For instance, assume that the dry bulb thermometer indicates 80° and the wet bulb thermometer indicates 60° temperature. The intersection of these two lines referred to the vertical axis shows that 1 lb. of dry air is mixed with 45.92 gr. of moisture and, referring to the horizontal axis, the mixture contains 26.15 B.t.u. of heat. Also, projecting this intersection horizontally to the saturation curve, the dewpoint temperature is found to be 46°.

The relative humidity, by definition, is the ratio of the vapor tension at 46° to the tension at 80°. From the steam tables these tensions are, respectively, 0.1532 lb. and 0.505 lb. absolute pressures per square inch. Therefore, the relative humidity is 30.3%.

Relative humidity curves may, of course, be drawn

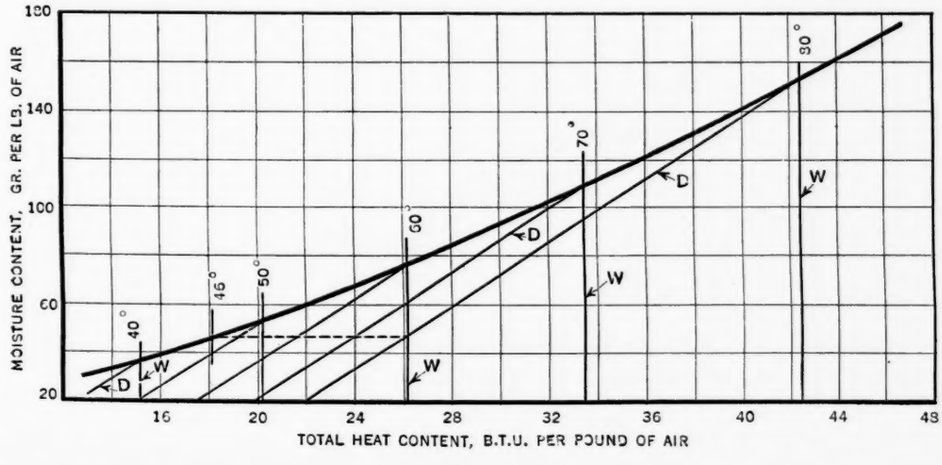


Fig. 3

upon this chart, but it is thought that they would unnecessarily create more or less confusion and, as the great majority of relative humidity values would be a matter of interpolation anyway, the curves have been omitted.

It is evident that relative humidity curves are of the general shape and character of the curve of saturation.

Another set of isometric lines, however, may be imposed upon the chart with advantage. These are lines of *effective* temperatures.

Effective temperatures are now so universally known and understood that they need no further amplification here. It is sufficient to say that in still air the relations of effective temperatures to dry and wet bulb temperatures, when transcribed upon the chart under consideration, will appear as straight lines, having an angularity with the horizontal axis different from either the dry bulb or wet bulb temperature lines.

(To be continued)

* * *

British Government Tests Industrial Air Conditioning

THE Chief Inspector of Factories and Workshops of Great Britain in his annual report for 1930 describes an air conditioning hut at the Home Office Industrial Museum which is equipped to demonstrate the effects of air conditioning. This hut is so arranged that visitors may not only feel the effects of changing conditions, but these conditions are under full control. The following, quoted from the report, describes a demonstration:

When a demonstration begins the air in the hut is in a cool, still condition. By starting the fan, the air is made to circulate round the passages in which the visitors stand. The effect of the air movement is to produce a sensation of coolness although the actual temperature of the air remains unchanged. As the velocity of the air movement is increased, the feeling of coolness is increased, since the movement of the air causes an excessive loss of heat from the body until eventually actual discomfort is produced.

By standing between the electrically-heated panels, however, the body receives radiant heat which compensates for the heat delivered up to the moving air, and this combination of radiant heat with air at a comparatively low temperature moving at a reasonable velocity produces a very comfortable condition. The heat being supplied by radiation, there is no substantial variation in air temperature.

By turning on the steam jets in the air passages, the humidity of the air is increased; this is done with the fan out of action. The temperature of the air is also slightly raised owing to the introduction of the steam. These conditions result in a feeling of lassitude as the cooling power of the air has been reduced, and sufficient heat is not removed from the body. It can then be demonstrated how when the fan is started the conditions immediately become more comfortable and feel cooler owing to the moving air having increased cooling power though, in fact, the temperature and humidity remain the same as before the fan was started. If the fan is again stopped, humidification can be continued to a point at which a fog is produced and the atmosphere becomes oppressive. By starting the fan immediate relief is felt and gradually the fog vanishes.

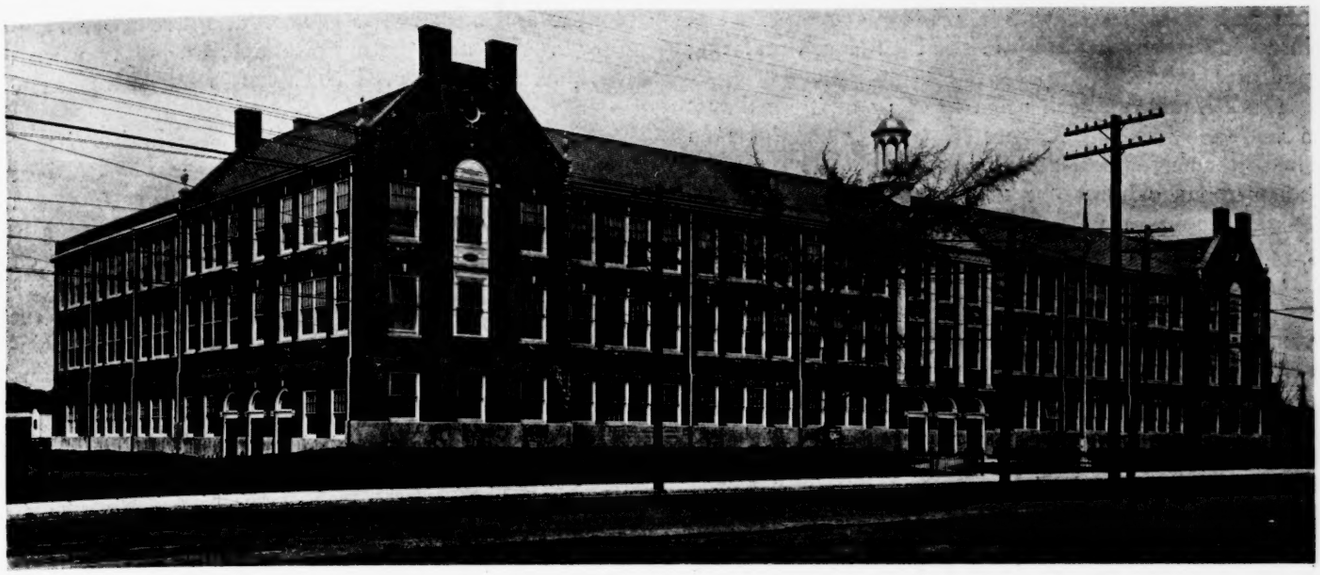
The advantages of air movement under different conditions smay also be demonstrated. By turning off the steam jets and keeping the air in circulation through the convection heaters, the air temperature gradually increases. The rise in temperature causes a fall in the relative humidity, and so long as the air is moving the conditions are pleasant. Under the same conditions of humidity and temperature, but with still air, discomfort is felt. This is shown by stopping the fan, when the air will feel too hot.

The discomfort can be increased by turning on the steam jets again and so producing an atmosphere which is both very warm and very humid, and without air movement. Under such conditions any physical effort would be difficult and exhausting. The pulse rate and breathing rate will be found to have increased. The great advantage of air movement is then shown by starting the fan. Breathing at once becomes more free and there is a general feeling of relief due to the air movement alone, the temperature and humidity remaining unchanged.

When the warmed and humidified air is allowed to remain stagnant for a few minutes, there is a considerable difference in temperature at different levels. The upper air is much warmer than the air near the floor. This condition produces an uncomfortable feeling of oppressive warmth round the head and coldness of the feet.

The principles emphasized in the demonstration are capable of wide application in industry. This is particularly true of those industries where abnormal atmospheric conditions are produced in the manufacturing process—as in dyehouses, laundries, etc.—or where artificial air conditions are rendered necessary by the process carried on. It is shown that for both comfort and efficiency the heat removed from the body must balance the heat produced when working. An atmosphere incapable of removing sufficient heat can be improved if the air is kept in motion. Where the heat loss from the body is excessive the remedy is a supply of radiant heat.

The air conditioning hut has served the useful purpose of bringing these facts to the notice of employers and others who had been unable to produce satisfactory conditions, consistent with the carrying on of the manufacturing processes, by the application of older ideas of ventilation.



Architects and Engineers, Monahan & Meikle *Heating and Ventilating Contractors, Lincoln & Lane Company*

Lyman B. Goff Junior High School, Pawtucket, R. I.

A High School Saves $3,000 a Year with Gas Heat

By CHARLES S. HILTON†

A fuel and labor cost (without crediting labor saved) of 25 cents per equivalent square foot of radiation per year is the record made by this well-designed and constructed school in New England. The mechanical equipment, which is modern throughout, includes gas-fired boilers and a vacuum heating system.

PARTICULAR efforts have been made in the design and equipment of the Lyman B. Goff Junior High School, Pawtucket, Rhode Island, by the architects and engineers to insure the comfort and well-being of students and teachers. The heating and ventilating system used is of modern type and is provided with controls which are considered to be both positive and reliable.

The building, facing east, is 258 ft. front and has two wings 148 ft. deep with three full floors, having 11½ ft. ceilings. With the exception of the gymnasium, auditorium and rooms under the stage, the entire building is above the grade level. In these rooms the floor is approximately 5 ft. to 7 ft. below grade. The compactness and low water line of the gas-fired boilers made it possible to build the boiler room floor, with the exception of the small pit where the pumps are located, at the same level as the main floor, resulting in a very substantial saving in construction costs.

The cubical content of the building is approximately 925,000 cu. ft., with a total floor area of 77,000 sq. ft. It will accommodate 1,350 pupils. The auditorium has a seating capacity of 690. In all there are 34 classrooms, six shops, a study hall, a music and dramatic room, a school library, a cafeteria and kitchen, two shower rooms, and 38 smaller rooms used as offices, dressing rooms, toilets, storage rooms, meter room, boiler room, janitor's rooms, and others, making a total of 106 rooms in the building.

The average size classroom is 23 ft. x 27 ft., with 11½ ft. ceilings and a volume of 7,142 cu. ft.

Each classroom has its own ventilating unit which warms and delivers into the room about 700 cu. ft. of outdoor air per minute, or approximately six complete air changes per hour. This unit delivers a stream of air vertically, which strikes the ceiling and spreads out in all directions. This stream mixes with and stirs up the air already in the room. The idea of this form of air distribution is that this continual agitation results in a uniform temperature of the air in the room. In most rooms the one unit also provides all the heat necessary. A few rooms, however, with extreme exposure have a supplementing steam radiator which balances the greater heat loss.

There are two unit heaters in the gymnasium having a combined air delivery of 3,830 c.f.m., and which have proved adequate for heating and ventilating. A

†The Pawtucket Gas Company.

fan and blast heater with a capacity of 6,200 c.f.m. installed in the auditorium is used for ventilating purposes only.

Flues lead from each room to carry off the exhaust air. The flues are connected with main ducts in the loft where motor-driven fans, controlled from the boiler room, exhaust the used air from the building. While the room units are in operation it has been found unnecessary to operate these exhaust fans.

Due to the building being insulated and weather-stripped throughout, and because all air intake and ventilating dampers are closed when school is not in session, the drop in temperature at such times is very slow. Recording thermometers placed in classrooms have seldom recorded an inside temperature below 50° from Friday afternoon until Monday morning, during which time the heating plant has been closed down. Temperature records show that during the warming-up period in the morning the temperature increases at the rate of from 10° to 17° per hr. by circulating the air. This plant has demonstrated that a tight, well-insulated building in which an efficient gas-heating system with rapid circulation is installed can reduce its fuel requirements by shutting down the boilers at such times as the building is not in use. The gas-fired boilers used have proved well adapted for this class of work, owing to their quick steaming qualities, flexibility, and ease of control.

Construction of the building follows the modern trend in so far as insulation is concerned. The walls, varying in thickness from 12 in. to 20 in. are brick, furred inside with a plaster base which is a combination of metal lath with a ½ in. layer of a board insulation, which, according to its conductivity, is the equivalent of an additional 8 in. in thickness of brick. The ceilings of all corridors and music room are lined with ⅞ in. acoustic tile. The construction of the ceiling and flat roof combination includes plaster on metal lath, two air spaces, three ply quilt insulation, 2½ in. concrete slab cinder concrete fill, ⅞ in. roof insulation, and composition roofing. The portion of the building having a pitch roof is of similar construction except that quilt insulation, cinder concrete fill, roof insulation and composition roofing are replaced by an attic space above which are roof boards with felt roofing paper and aluminum shingles.

Inasmuch as there is approximately 16,000 sq. ft. of exposed wall area and 24,000 sq. ft. of roof exposure, the insulation installed results in a large reduction in heat loss with a corresponding saving in fuel.

The windows throughout the building are equipped with weatherstrips which not only help to eliminate cold drafts while school is in session, but materially reduce the air infiltration during the period averaging 118 hr. weekly that the system is not in operation.

Three sectional cast iron gas-fired steam boilers are installed in the boiler room. These furnish steam to the heating system supplemented by a smaller gas-fired steam boiler used as an auxiliary at times in which a comparatively small amount of steam is required, as in caring for the gymnasium, auditorium or for supplying hot water. Each of the three large boilers has an A.G.A. rating of 9,620 sq. ft., or a total for the four boilers of 35,520 sq. ft., or 254 boiler horsepower. The total rated maximum gas consumption is 20,486 cu. ft. per hr. Each boiler is set on a concrete base.

The boiler flues are of No. 16 gauge lead clad steel plate. The three heating boilers are controlled at varying steam pressures: No. 3 boiler control starts to throttle the gas supply at ½ lb. and cuts off at 1 lb. pressure; No. 2 boiler throttles at ¾ lb. and cuts off at 2 lb. pressure; No. 1 boiler throttles at 1½ lb. and cuts off at 3 lb. pressure. In this way a constant steam pressure in the main steam header is maintained between 1 lb. and 3 lb. during the heating periods. Any variation in the amount of steam automatically supplied to the heating system is balanced by the flow of gas to the boilers. Any thermostat calling for heat opens the motor-operated steam valve of that zone and the resulting drop in steam pressure in the steam header automatically increases the gas flow to the boiler or boilers in operation at the time.

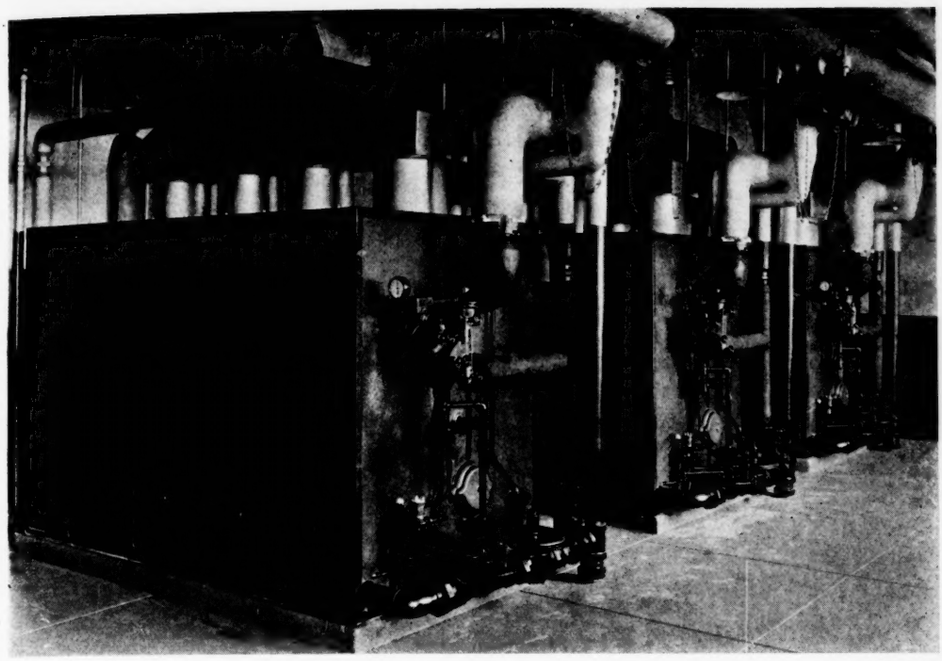
It was felt advisable to have a time control for the operation of the system as well as a temperature control, and this is accomplished through the action of an electric time switch installed in the boiler room and wired to solenoid valves on the three heating boilers. At a predetermined time in the morning the time switch starts the boilers and shuts them down at a designated time in the afternoon. A week-end skip attachment prevents the operation of the boilers from Friday afternoon until Monday morning. Both the starting and shutting down time may be easily changed as required by the seasonal variation in outside temperature. Around each solenoid valve is a by-pass with a stop cock which provides a manual master control. Opening this by-pass holds the boiler off independent of either the time or pressure controls. Any, or all of the boilers, which it is intended to start in the morning is left with the by-pass closed during the night.

The gas supplied to each boiler is metered separately through a meter having a gas capacity of 6,000 cu. ft. per hr., giving a convenient record of the fuel consumed by each boiler. This plan also necessitates but one reserve meter being carried in stock.

The boiler room walls are painted aluminum with a brown wainscoting. The piping, valves, boiler flues and hot water tanks are also painted aluminum, while the boiler casings with their dark grey enamel finish, make a very pleasing contrast. The boiler room is kept as clean as any other room in the building with the entire elimination of dust, odors, noise or fire hazard.

William A. Newell, superintendent of schools, estimates that a yearly saving in labor of $3,000 can be attributed to the use of gas as a fuel.

The actual maximum heating load of the heating equipment installed is 22,450 sq. ft. A high vacuum heating system is installed which is divided into five sections, or zones, each of which is an independent system in itself, thermostatically and automatically controlled. The five zone thermostats are wired to corresponding switch and signal panels in the boiler room, and from the panels electrical connections are made to the main motor-operated steam valves which



The boiler room is built on the same level as the main floor, resulting in a saving of construction costs. Three gas boilers supply the heating system, while a smaller gas boiler supplies hot water.

control a continuous flow of steam to the zones at pressures varying from 2 in. to 25 in. of vacuum. Electrical switches place the zones under automatic or manual control at will. Colored lights on the panels indicate the room temperature at the various thermostats, also indicating if the steam valves are open or closed. A duplicate panel in the principal's office shows at a glance the temperature conditions and the manner in which the system is responding throughout the building. Gauges in the boiler room indicate steam pressures or vacuum in each of the five zones. Each ventilator and radiator is fitted with a fixed orifice plate in the supply valve, resulting in a metered flow of steam at all times when operating.

The vacuum pumps which handle the air and condensation from the heating system are automatically controlled by a float in the receiver installed with each pump and also by a pressure difference governor. The float controls operate the pumps, returning the condensation to the boilers irrespective of the vacuum carried. The controls maintain a vacuum in the return piping, during operation, greater than the pressure or vacuum in the steam supply pipes. The steam returns from the cafeteria and hot water storage heaters are piped to a separate receiver and pump and from there discharging either to the small boiler, if in operation, or to the main return header of the heating boilers.

In addition to the building heating, steam is required for heating water in two hot water storage tanks and for steam tables in the cafeteria. The piping in the boiler room is so arranged that steam for all purposes may be supplied from any one of the boilers, or the small boiler can be operated to care for either the auditorium, gymnasium, hot water tanks, or cafeteria alone. The hot water storage heaters are located at one end of the boiler room. A 1500 gal. tank supplies the water at a temperature of 160° to the shower baths, lavatories, sinks, etc. Another tank, with a capacity of 400 gal., supplies water at a temperature of 180° to the cafeteria and dressing rooms in the auditorium. Each storage tank is equipped with a thermostatic temperature regulator operating a steam valve.

The gas equipment in the kitchen comprises one restaurant range and one bake oven. In the domestic science rooms two cabinet gas ranges and 12 box oven ranges are in use, together with several small furnaces and burners in the machine and metal working shops, to all of which gas is supplied through a separate meter.

The heating plant was placed in operation early in March, 1931, and indications are that it will continue to operate well within the estimate of 12,000,000 cu. ft. per year for heating, water heating, cafeteria, domestic science and shop work.

Monahan & Meikle, architects, of Pawtucket, prepared the plans and specifications and supervised the construction and equipment of the building. The installation of the heating and ventilating system was made by the Lincoln & Lane Company of Pawtucket, cooperating with the engineering departments of many of the manufacturers whose equipment is used, and the engineers of the local gas company.

Equipment

Blast heaters—Aerofin
Cast iron radiators—American Radiator
Gas boilers—Bryant
Heating system—Dunham Differential Vacuum
Hot water storage heaters—Sims
Insulation, ceilings—Cabot's Quilt
Insulation, pipe—Johns-Manville
Insulation, roof—Johns-Manville
Insulation, walls—Flaxlinum
Pipe and fittings—Grinnell
Pumps—Dunham
Thermostats, heating system—Minneapolis-Honeywell
Thermostats, hot water heating—Powers
Time switch—Sangamo
Unit heaters, gymnasium—Dunham
Unit ventilators—Herman Nelson
Weatherstripping—Chamberlain

Some Practical Methods of Eliminating Noise

By EVERETT S. BUCK†

In which the author discusses some causes of noise in air conditioning systems and explains how to correct the trouble

TOO often the only thing kept quiet about a small fan job is the fact that it is noisy. Too often, indeed, for the only inherently necessary noise is a portion of that which is caused by the contact of the fan blades with the air, and this may be reduced to a mere breathing sound, similar to that of a kitchen range gas burner, but lower in tone and less in volume.

Improvement in multiblade fan design may be credited with most of the progress in noise reduction but, unfortunately, the same improvement has not embraced the smaller fans commonly used for residence work. There is some justification for this, however, as the manufacturing problem is analogous to that of building a fine watch compared with an alarm clock. Building a really quiet small fan is a precision job, and such a fan is necessarily costly. Competition, however, has led to the market being flooded with carelessly-built lightweight small fans.

It should be understood and acknowledged that the crux of the problem of noise in small installations is the fan and its motor; the duct system has very little to do with it. So little, that the observance of a few simple and widely-known rules will obviate noise which actually originates in the ducts. The duct system can actually be made a valuable adjunct in absorbing the noise generated by the fan, motor, or, in the case of direct-fired furnaces or boilers, noise due to the combustion of gas or oil. This reduction of noise in the ducts is accomplished by the simple and effective expedient of lining them with a sound absorbent material.

While the related subjects of sound and acoustics are scientific and technical, it is not necessary to understand any more than the following simple elements in order to give first aid to a sick installation:

1. The noise we hear consists of sound waves of varying frequency and intensity. Note that both frequency and intensity vary. By frequency, we mean simply the number of vibrations in a given period of time. We have all seen and heard saxophone quartets, no matter how we may have tried to avoid them. The little one that makes the high-pitched squeal has a short reed which flutters rapidly, while the reed of the big bass saxophone moves back and forth comparatively slowly.

Intensity is also of importance and can be illustrated by a simple example. What makes more noise than one saxophone? The answer is:—Two saxophones. A well-placed shot will stop one saxophone, two shots will account for two, and similarly, it may require a half-inch thickness of absorber to absorb one sound while another of exactly the same pitch or frequency will require two half-inch thicknesses, because there is more volume, more actual force.

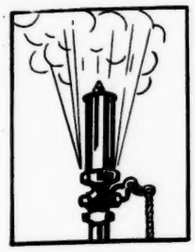
2. Sound waves travel in absolutely straight lines, and the effect varies as the square of the distance from the source, i.e., they sound four times as loud at 2 ft. as at 4 ft. distance. If a sound wave strikes the side of a duct at a 45° angle it will rebound from it at a 45° angle forward and toward the other duct side, just as a billiard ball rebounds from the cushion. If we should substitute a deep cushion of sponge rubber for the quick springy reaction of the very dense rubber billiard table cushion, the ball would not rebound vigorously but would, if we made the sponge soft and deep enough, stop right there.

So it is with sound. We can absorb much of it by merely lining the duct for a short distance, if the duct is not too large. Obviously, if the sound has so much volume that we must soften it several times, we shall need a greater length of lining to absorb the angularly generated waves, especially if the duct is of large cross-section. An elbow lining is the obvious trap for the straight line noise.

Sound absorbent materials are rated on their percentage of efficiency compared between 100% of sound rebound and no rebound — a condition which is approximated if a sound wave is directed outward through an open window. Inferentially, the ideal material would consist of a surface similar to a honeycomb with infinitesimal holes of sufficient depth to absorb and trap the sound wave, yet presenting a surface which would cause the least eddy flow depth with its consequent friction and loss of pressure.

Loss of pressure caused by friction is an important element of design. After all, it is not mechanically difficult to produce a fan which will move air quietly at low pressure against a small total duct resistance, but that is not a full solution to our problem. We cannot go on forever using 10% of the cubic contents of a house to hide big ducts just because we are too lazy or indifferent to build and mount our fans properly. If the system were charged with the cost of this space, we would quickly de-

† Consulting Engineer, Cincinnati, Ohio.



cide to use the least possible air at the highest possible velocity, and demand fan-motor combinations capable of producing the required pressure without objectionable noise.

The whole related problem calls for a better solution, and it is not a simple one, since difficulties increase, not directly, but as the square. Thus, air flowing at 600 f.p.m. velocity, has a kinetic force equal to 0.0225 in. water column, but air flowing at twice the velocity has four times the pressure, or 0.09 in. for 1200 f.p.m.

The value of increasing the velocity from 600 to 1200 is seen by the fact that a duct only half as large need be used. The cost of power for these velocity differences is actually negligible—less than the interest on the difference in cost of the duct work for such work.

Conceive a straight 12 in. round galvanized iron duct 55 ft. long, at the end of which we wish to deliver air at 600 f.p.m. velocity, and with a total friction loss equal to the velocity pressure. The air will enter at 600 f.p.m. velocity and will leave at 600 f.p.m. velocity. When it enters, it will have a total pressure (velocity plus static) of 0.045 in. of water, whereas it will have remaining at the instant of leaving the duct only that pressure required for the production of 600 f.p.m., or 0.0225 in. For 1200 f.p.m. velocity the total pressure entering must be 0.09 in. static pressure, plus 0.09 in. velocity pressure = 0.18 in.

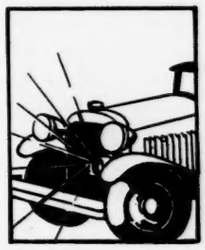
This total pressure must be given to the air by the repeated action of fan blades pushing against it. This action must produce smooth sustained pressure without sharp eddy currents. Consider the construction of the usual type of fan wheel in its housing and you will realize that a large diameter fan wheel will produce a higher pressure without noise than a similar small wheel. Herein lie two frequent sources of noise, viz.: (1) a poorly-designed fan wheel (or housing), and (2) too small a wheel, necessitating too high a speed to produce the required pressure.

The production of noise because of eddy or turbulent motion of air has not been sufficiently explored, but the consideration of some well-known facts here will serve to explain what may or may not be done with sheet metal ducts, if they are not to cause noise.

The flat statement may be made that air flowing at 1800 f.p.m. velocity in round commercial galvanized iron ducts will not cause audible sound, and this writer has designed many large and quiet ventilating systems with trunk velocities of 1500 f.p.m. to 1800 f.p.m. At this velocity, branches and elbows should be given a throat radius equal to one and one-half times the branch pipe diameter if space permits.

With such construction in proper gauges, there will not be present what is commonly supposed to be "air noise" caused by high velocity in the duct. If there is noise, trace it back to its source and do the most expedient thing—either repair or replace the offending member, *if you can find it*, or absorb the noise by lining the duct.

Those words—if you can find it—mean a great deal more than one might suspect. Thousands of dollars have been thrown away because of mistaken ideas and conclusions as to the origin of the offending noise, and in many cases a simple lining treatment of the duct would have sufficed.



Duct acoustical treatment is not an infallible prescription, however. Some years ago the writer investigated a large church where money had been spent lavishly. Enough ducts had been installed for twice as much air as was being handled, and that was twice what would have been necessary if introduced properly. Fans there were a-plenty; motors were variable speed; heating surface—everything—was at least double the required size.

But what a whistle there was. The moment the big main supply fan passed the fifth of the twelve speeds available on the motor controllers, a million crickets apparently began to chirp in that church. When we reached the scene, everyone involved was blaming the other fellow's equipment. Fans, motors, heating surface, washers—all came in for their share—and every item was found perfect, too.

High up on the walls were the principal air introduction grilles. To pass a truss, the branches to these grilles had been carried straight down through a 6 in. x 48 in. duct, which was opened by 48 in. wide x 36 in. grilles in the same way a gravity wall register opens a wall stack. The result was a velocity through the extreme lower portion of the grille that caused an anemometer to read 1300 f.p.m., and it was a pretty good anemometer, properly handled. At the top of the grille air was rushing back in at nearly 350 f.p.m. The grilles were delivering their expected 4800 c.f.m., but the good old design figure of 400 f.p.m. was not much consolation when the crickets started chirping.

It seems that somewhere around 1300 f.p.m., almost any sharp change in air flow direction sets up a turbulence which will produce noise, and if the air column is wide, the volume of sound produced will be objectionable. Consider the result if we duplicated this effect in a grille only an inch wide at the high velocity point. If the duct was high on the wall, the noise would probably be unheard at the floor. While the frequency or tone pitch is the same, the volume is lacking.

A hiss of air is detectable when the air is split by a sharp fin at actual velocities above 1200 f.p.m., but the total volume of sound caused by such disturbances as may accidentally be built into commercial duct work can probably be disregarded.

In working with rectangular ducts presenting large flat surfaces, care is necessary not only with regard to gauges of metal, but also to see that no large area is without a good external stiffening angle or break.

Air flow at an elbow may, and frequently does, become so turbulent as to impose the total pressure on the duct side, and cause the whole side to flutter. The eye may not be able to detect the vibration, but the sensitive finger tips will.

One difficulty in applying corrective measures in sound problems is that sound waves "telegraph." That

is, they reappear at remote points just as mechanical vibrations which originate at one point appear visibly or audibly at another. One may be firmly convinced that a noise originates as magnetic hum in the motor, but may find it in the fan cut-off sheet, for those sounds under certain conditions are identical in both tone and volume. Another, and we should say a less experienced observer, will be equally certain that the duct system is responsible.

For such a condition the one thing which we may determine definitely by careful inspection is that the noise is being transmitted through the duct, and can be absorbed sufficiently by lining it. In small ducts, the writer has had good results with a ½ in. thick felt stitched to paper.

Very small ducts will need to be replaced by larger ones which provide the original area, but the lining treatment can be applied to the main duct. Comparatively few existing jobs will be encountered where the reduced area caused by lining will materially reduce the air flow.

In applying a flexible lining material to existing ducts, the writer has followed the following procedure. First punch the duct with small holes in pairs 2 in. apart, with the pairs on approximately 6 in. centers for the top and sides of the duct, taking care to start these about 1 in. from the edges of the felt. Then paste the duct, apply the felt to the wet paste and twist fine strong wires through each pair of holes, turning the wire ends down to serve as additional hold-downs. Large ducts have been lined with this material by securing the felt by narrow No. 26 gauge strips with a sharp 3/16 in. break on each edge to cut into the felt, drawing these strips down to the level of the felt surface. The object of pasting the duct is to offset any tendency of the material to bag when drawing up on the wires or hold-down strips.

Some day we shall have fans and motors so quiet that installation will not be a factor in sound prevention, but in the meanwhile we must install what we can get in such a manner as not to add unnecessary noise. I believe that it is absolutely necessary to mount fans and motors on some kind of a vibration absorbing base or we shall have purely mechanical noises, which will increase with time, for no matter how perfectly we filter the air, dust will collect at oil spots on the fan blades in sufficient quantity to cause dynamic unbalance in a lightweight propeller. No matter how perfectly we lubricate and fit our bearings, even when we broach them (which, to the writer's knowledge, is so far not being done), wear will occur, and even the slightest dynamic unbalance will then be evident as bearing noise.

If, instead of bolting the motor and fan down solidly, we provide adequate absorption in all planes vertical and horizontal to the axis, as well as parallel to the shaft, the rate of wear will be greatly decreased. Too, even a decided lack of dynamic balance may be clamped sufficiently to be inaudible.

A common method of absorbing the vibration is to carry small rotor loads on light leaf springs extended radially from center, but the writer prefers fine coil springs, the finer the better.

Absorbers such as sheet cork are popular, but we should not expect too much of these absorbers when they are of only 1 in. thickness. Use several sheets and get the value of the air cushion between the sheets.

The value of rubber for absorbing purposes depends on its chemical composition as well as its physical structure. Most "rubber" compounds harden rapidly and lose their absorptive qualities, and they must be protected against oil or their deterioration is hastened.

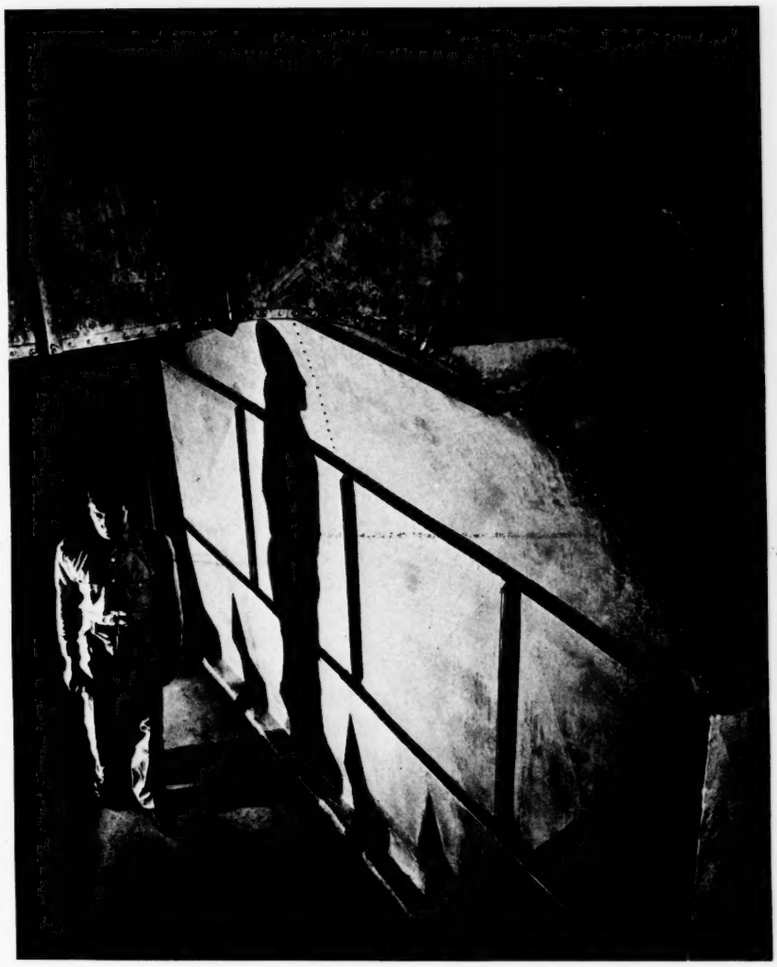
One rather novel and effective use of rubber with which the writer came in contact, consisted of a short center V-belt drive fan and motor secured to a 5 in. concrete slab which was isolated from the floor by means of a number of 10-cent live rubber golf balls. The slab was spaced equidistant from a surrounding concrete curb, the space was filled with hot asphalt and the balls were spaced with the same material. Vibration, which was very apparent in the slab, was not carried through to the floor, but it is questionable whether the asphalt will serve to protect the rubber for a long period.

There are so many comparatively inexpensive methods of vibration-sound absorption available that it is surprising to see recent specifications which call for nothing of the sort. Certainly the contractor who submits a competitive bid cannot be expected to supply more than is specified, so we must look to the engineer's influence for real progress in noise elimination.

Albany's skyline

Air Conditioning and Cooling for Heating Contractors†

By WALTER L. FLEISHER



THERE is no longer any reason for my coming before you with the warning that air conditioning is encroaching on the business of the heating contractor. The day has arrived when air conditioning is the subject uppermost in everyone's mind when the subject, heating and ventilating, in any of its phases is mentioned. It is not a question, today, as to whether you, as heating contractors, should consider the advisability of entering into air conditioning, but rather a question as to how quickly you can adapt yourself to the new conceptions of air conditioning in order to stay in the heating business, because inevitably with the development of air conditioning and its simplification and its consequent cheapening, every heating job, in my mind, will eventually be an air conditioning job.

A metamorphosis of this kind is always retarded by the reluctance of the manufacturer and contractor to discard those things that he has been accustomed to make and those things that he has been accustomed to install for others which superficially appear radically different. The result is that today the manufacturer is attempting to turn his present product into a new product which he calls a conditioning machine, and the contractor is attempting to avoid the installation of such devices because either he does not thoroughly understand them, or thinks them a new-fangled contrivance, or because his customers will still accept the old-fashioned products which he, as contractor, has been accustomed to sell and install, and which to their mind have always satisfactorily performed the work which they were expected to do.

In our whole history of development there has been really nothing in the line of mechanical evolution which

†Abstracted from a paper presented at the forty-third convention of the Heating and Piping Contractors National Association, May 16-18. Copyrighted by this association. Photograph by Eastman Kodak.

has proceeded much more quickly than the evolution from straight heating to so-called air conditioning. There is not a manufacturer of any size heating devices today who is not devoting a considerable amount of his time and money to the development of air conditioning devices, or the changing over of his present products for use in air conditioning. Our largest manufacturer of heating devices informed me that they were spending on the development of air conditioning devices more money at the present time than on all the rest of their development put together, and this same company laughed at me only three years ago when I warned them of this rapid change and suggested constructive methods of meeting its approach.

I feel that all of you would more readily appreciate this subject if I defined air conditioning as I see it. Air conditioning is the simultaneous control of temperature, humidity and air movement. Now, all three of these divisions of air conditioning are inherent in every heating system, but most of the time in our present heating systems they have no relationship to each other. In order to make air conditioning effective, they must have some relationship to each other, and when I say the simultaneous control, I do not necessarily mean automatic control, except as it is inherent in the apparatus which is installed to produce the conditions. A radiator of any kind may produce the required temperature. If moisture is not introduced at the same time as heat is transmitted or radiated, this very heating may lower the relative humidity. At the same time the temperature of either the radiator or the room itself or the air in the room which has been heated by the radiator may create an air movement more rapid than the movement before the radiator was heated. The resulting conditioning may possibly be more unsatisfactory than a properly controlled temperature either of the room or the radiator or both. The proper amount of moisture artificially introduced in the winter time, to maintain a comfortable relative humidity and a regulated air movement which will distribute the heated and moistened air across the body, may create a feeling of comfort which is the only criterion of proper heating.

Air conditioning, from a theoretical standpoint, is not simple. Changes take place in a mixture of air and moisture, the final results of which have been worked out on theoretical formulas, but it is my feeling that the heating contractor would simply involve himself in endless mazes of confusion in attempting to master this subject from a theoretical angle. Notwithstanding the complication of the theory of air conditioning the heating contractor must have some rule-of-thumb measuring sticks by which he can protect himself against the vast number of impractical and inefficient devices which the very pertinancy of this subject is bringing into the market. I could give you the names of some 28 to 30 so-called manufacturers or dealers in these devices with prices running from next to nothing to very large amounts, and unless some idea of what is required were understood by the heating contractor, he would not be in a position to balance the cost against the value of what he intended to buy.

The heating contractor who is gradually going to be forced into air conditioning is also going to be confronted in the next few years with the slogan of comfort conditions and effective temperatures, and is going to have to use these terms, or at least understand them, in order to function in the air conditioning field. Actually, comfort zone and effective temperatures are names to represent comfortable conditions involving more than the ordinary thermometer reading with which the contractor is accustomed to deal. Through experiments or tests or similar methods, heating and ventilating engineers have determined that there are quite a number of temperatures that can be read on a thermometer which give equal comfort when combined with different amounts of relative humidity. Then, in the winter time a group of people who experienced this found that they felt as comfortable in rooms of 65° or 66°, when the relative humidity was around 40% or 45%, as they felt when the thermometer was 70° and the relative humidity considerably lower. Also, in the summer time they felt as comfortable with a high temperature and a low relative humidity as they did when the temperature was lower and the relative humidity higher. These tests were worked into tables and equal conditions of comfort were called equal effective temperatures, and the range under which a large percentage of the whole group felt comfortable was called a zone of comfort. These conditions were also affected by the velocity of the conditioned air over the bodies of the people.

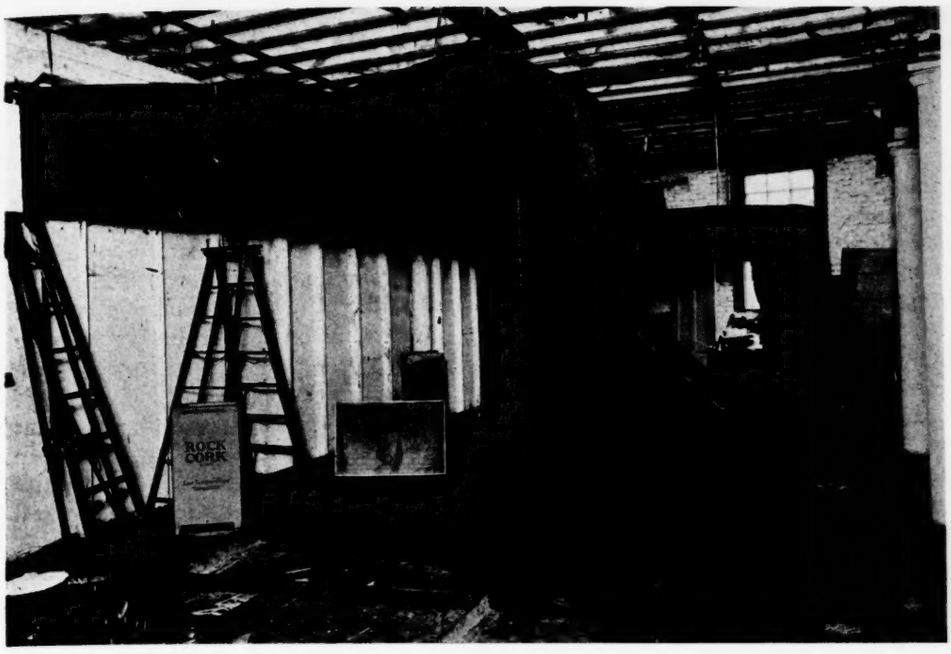
For winter heating the old dry bulb temperatures of 68° to 70° with a fair amount of relative humidity are still comfortable conditions. With the addition of some moisture, lower dry bulb temperatures are quite comfortable.

It would also be well for the heating contractor to know something about moisture in air. Probably most people know that air is a mechanical mixture of oxygen and nitrogen and that for ordinary temperatures and under ordinary atmospheric pressure 1 cu. ft. of air weighs about 1/13 lb. The moisture which is in the air, for there is always moisture in the air, is not the same thing as water, any more than steam is the same thing as water, although it is developed from the same source. In fact, the moisture in the air is much more like steam than it is like water, and is usually considered a perfect gas.

The difficult thing to understand is that two gases, air and steam, can occupy the same space. In other words, increasing the amount of moisture in the air is not in any way dependent upon the space occupied by the air, but only by its temperature. Air can hold moisture in the form of steam or vapor in definite quantities, dependent entirely on the temperature of the air. But the pressure exerted by that particular cubic foot of air is the pressure exerted by the weight of the air plus the weight of the vapor.

When air at 70° holds all of the vapor it can hold, it contains 8 grains of moisture by weight. If this air is cooled to 50°, 4 grains of moisture would drop out and then, if the air is heated again to 70° and no moisture is allowed to get in and the cubic foot of air only had 4 grains of moisture at 70°, it would have half the moisture that it could hold if saturated, and would have what is known as 50% relative humidity. In other words, the relative humidity is the proportion of moisture as a vapor in air, compared to the maximum amount of moisture it can hold.

Also, it is well to bear in mind that all materials



Rock cork insulation on air conditioning ducts

that dry up and warp normally have a definite amount of moisture in them, which is extracted by the air when the air is relatively dry, and it is to take care of this undesirable result that moisture is introduced into the house or office as much as it is to remove the discomfort of the people. At least, people can go out of the house or drink a great deal of water or something of that sort, but the furniture, hangings and things of that kind are helpless in a dry atmosphere.

It is the overcoming of these conditions and the relief which is felt when the proper amount of moisture and the lowered temperature is produced which have given rise to the introduction of air conditioning methods in the places in which people live or assemble. In this discussion, I am concentrating on the relief of winter conditions. The heating contractor in his work and in his efforts to overcome the hazards of climatic changes has been interested primarily in the relief of winter conditions.

The progress of cooling for comfort has been of later growth. Up to the time that the large moving picture theaters installed cooling, cooling for comfort was more of an idea than an actuality. Since then the cooling game, catching the imagination of the people, has gone ahead very rapidly and enlisted the services of practically all these people who had developed household refrigeration, as this appeared to be an outlet for them to take up whatever slack they might have in their product schedule for refrigerators. Unfortunately, they had as little conception of the requirements of cooling for air conditioning as the heating contractor has of the requirements for refrigeration. But something is going to come of this to the advantage of the heating contractor, if he is prepared, and I shall return to this part of the subject later in my discussion.

You remember that I said in the earlier part of this address that at 70° air could only hold 8 grains of moisture per cubic foot. Beyond that any moisture added falls out and condenses and becomes a nuisance. Also, when air is nearly saturated, the tendency for moisture to deposit on the windows is very great and, therefore, the delivery of all of the moisture for a house in one location is likely to result in either over-humidifying at one point, and under-humidifying at others, or the depositing of free moisture near the point of introduction. It was this question of distribution which helped to further the development of so-called air conditioning warm-air furnace systems. Air outlets were distributed in many parts of the house and it was simple to add fans to the system to accelerate the movement of the moisture-laden air to the proper parts of the house. These systems also lent themselves very well to gas-fired operation and to the addition of some sort of cooling medium to give them an all year-round purpose.

Probably everyone here is familiar with this type of system and it was my suggestion to you some years ago that you should attempt to push the sale and installation of such systems in order to hold for yourself the advantages that you had built up over a period of years. However, the manufacturers of radiators, fans and similar devices have started in to build up a group of air conditioning apparatus to be used in connection with steam and hot water heating systems. Most of these devices are just the ordinary cast iron radiator with an integral evaporating pan of some sort or other.

All of these devices, or practically all of them, have radiator enclosures which by flue action develop an air current which assists in the evaporation and carries off saturated or partially saturated air to mix with the surrounding atmosphere. Most of these are designed for installation in the hallway of a house, so that the flue action of the stairways will give more rapid circulation of the moisture-laden air.

To this class of device may be added units turned out by refrigeration or fan companies, which are a cross between a radiola and a parlor stove.

All of the devices that are on the market today add two pipe lines to every installation, one to supply water to the evaporating surface, and the other to drain off the excess water which may not be evaporated in its passage over the surface. In union towns where the steamfitter may not install either water or drain pipe, this may cause considerable difficulty and confusion, which should be equitably settled in advance and, if possible, should be allocated to the heating group.

Of course, it is better to have a small amount of moisture evaporated in a number of places, but almost

any so-called air conditioning radiator or unit can evaporate sufficient moisture to take care of the requirements of the whole house. But the accessories required for the control of the evaporating medium are almost as expensive as the evaporator itself and, consequently, the desire to segregate and eliminate repetitions of this additional material and work is the main reason for limiting the use of it to isolated points.

Where a system of indirect heating is to be installed, or where the air conditioning or humidifying apparatus can be placed in the basement and distributed from one point to various parts of the house, a very simple and ideal method can be developed. Here the water supply and drain are easily and cheaply installed and all of the inconveniences of humidification are obviated.

Actually, the substitution of steam-heated air with central humidification is a much better installation than the central warm-air furnace systems and, today, with the central warm-air heating systems advocating the use of a fan, a central steam or hot water system, preferably steam operated either by means of gas or oil, will give all of the good effects of a warm-air furnace system and many advantages that a warm-air furnace system cannot furnish. For example, with a warm-air furnace system it is essential to keep the fan operating all times of the day or night, and even at that it is difficult or expensive to provide the essential heat in such rooms as bath rooms, halls, etc., when air circulation is not nearly so important as heat at all times. Therefore, if the heating contractor wishes to compete with the furnace contractor in providing a humidified and ventilated house, all he has to do is to sell to the owner the idea of a central heating system in which the boiler will take care of his hot water, his kitchen, his bath rooms, his halls and the small fan system will take care of the main living rooms and bed rooms to furnish the proper humidification for the whole house. It is true that this type of system costs slightly more than the furnace system, but it has so many advantages that the heating contractor should turn efficient salesmen to overcome the disadvantages of the price differences.

A question that will come up very often in the sale of air conditioning devices is as to whether it costs more to heat with higher humidity and lower dry bulb than with higher dry bulb and lower humidity, and to answer this the heating contractor will have to be familiar with the proper information.

To evaporate 2½ grains of moisture per cubic foot per hour requires, for the example that I have given, of a house supplied with 36,000 cu. ft. of air per hour, the evaporation of 12 lb. of water per hour, which is the equivalent of 12,000 B.t.u. which, at 240 B.t.u. 1 sq. ft. of radiation is the equivalent of 50 sq. ft. additional radiation. Now, if this house can be maintained comfortable at 67° instead of 72°, we have a differential in temperature between indoors and outdoors, say, for New York, of 57° instead of 62°, or 92% of the radiation for heating that ordinarily would be required. Assuming that a house of this kind would ordinarily require 400 sq. ft. of radiation, the decrease in temperature would save about 20 sq. ft. of radiation and the humidification would require, under maximum conditions, 50 sq. ft. additional. Therefore, properly conditioning the house would add between 7% or 8% to the total load under maximum conditions. But as the feeling of comfort is a function of the temperature and relative humidity, this in itself shows to a certain extent, that people require this additional heating (by heating I mean humidification) in order to secure comfort, and that they can secure it at approximately a 7½% increase in their load factor.

In most cases it will not be essential to explain this addition to the ultimate owner. The heating contractor can say that with the lower temperature required for comfort with proper conditioning, the total load on the house is very nearly the same. My explanation is made simply so that the heating contractor knows what he is talking about.

Of course, if the infiltration, which is only part of the heating that has to be compensated for by means of humidification, be cut down to one air change an hour instead of two, which is cited in this example, this statement that the humidification requires no additional load on the boiler is practically true.

So far, I have talked to you entirely about humidification, except for the merest mention of cooling. I have done this purposely because cooling is a new subject, a new engineering problem, something entirely out of the line of the heating contractor's thoughts or experience, but something with which he will have to become familiar, because the big refrigerating companies and motor companies and radio companies visualize cooling as their great future development. Their one desire is to obtain and develop this business at any cost. They really are more ignorant of what they are about, as far as air conditioning goes, than the boiler and radiator manufacturer is out of line with the requirements of winter humidification. But they are true promoters and salesmen, and are in a better position to put across their ideas than the heating contractors or the manufacturers supplying the heating contractors.

At their first approach in this field, which occurred during the boom period several years ago, they felt that they could force down the throats of the people a straight cooling device and completely ignore the heating. Today, due to sales resistance, they are adding to their cooling devices a winter heating and sometimes a humidifying attachment, in order to sell year-round devices to replace the radiator and evaporator.

It is obvious that if the heating contractor is to hold his place in the game he must be the person to furnish and install this combined apparatus, and then he not only has to understand the purposes of this device for winter heating and humidification, but also what I might call the reverse cycle of summer cooling and dehumidification. There are many factors in cooling and dehumidification which must be taken into consideration that are not important or which are helpful during the heating season. For instance, the radiant effect of the sun through the glass or on the walls which are acted on by the sun plays a tremendously important part in cooling, whereas in heating they are of assistance in maintaining the conditions desired. The same thing is true of the body heat given off by the occupants of an enclosure, or the electric lights, or the various electrical devices and apparatus which transform their function into sensible heat or create additional load on the cooling system, and to diminish the load on the heating system.

The removal of moisture from the air, which is so essential in producing comfort conditions in the summer time and which corresponds inversely to the evaporation of moisture for humidification in the winter, is a load factor which decreases the amount of cooling that can be done with any refrigerating system. The fact that cold air has a greater density than warm air prevents the cooling surfaces from being affected by gravity flue action and, therefore, reduces the surface transmission which during the heating season takes place to increase the capacity of the surface or units. These are some of the simpler things in cooling and dehumidification which it is well for the heating contractor to be familiar with in order to discuss with a fair amount of intelligence the cooling requirements with which he would be confronted.

Actually, as far as calculations go, straight cooling without the consideration of dehumidification or moisture elimination is not very different from the calculations for heating. Wall construction or windows transmit heat in the same relationship in the summer time that they do in the winter, except that the difference to be maintained between indoors and outdoors is less in the summer time than it usually is in the winter. In other words, assuming a heating problem from 0° to 70° with a difference of 70° between indoors and outdoors, this would in most cases in the summer time reduce to 20° as a maximum, that is, between 95° and 75°. However, as I have stated before, the solar radiation is a very important factor in the summer time, and creates conditions almost as severe as the larger differential of winter heating. Then, too, the surfaces from which heating or cooling develop have a much wider difference between the temperature of the heating medium and the temperature of the room than is possible in the summer time. In other words, with 1 lb. steam pressure the temperature of steam is about 215° and the room to be maintained at 70° gives a differential of 145°.

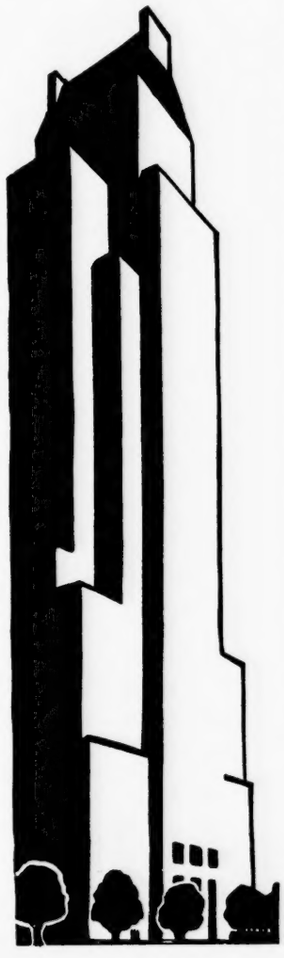
In the summer time it is not feasible to circulate a medium much lower than 40°, so that the differential between 75° and 40° is only 35°, as against the 145° differential of the winter. This requires more surface or a higher air circulation over the surface.

Practically all of the manufacturers of domestic refrigerators are or will be in the field to provide machines for household cooling, and whether the contractor obtains the proper size for his future installation will depend to a certain extent on the honesty of the refrigerating manufacturer and partially on his own rule-of-thumb knowledge of what the requirements may be. It is always well in purchasing a refrigerating machine for cooling purposes to have the manufacturer of the apparatus guarantee its output in B.t.u per hour, rather than in tons of refrigeration. It is also well to bear in mind in cooling that the elimination of 1 lb. of water per hour requires the extraction of 1,000 B.t.u., or 1/12 ton per hour, and that the extraction of the moisture from the air may give a feeling of comfort but will do no cooling except that cooling which must occur in reducing the temperature of the air to the point where the moisture falls out, automatically lowering the temperature.

In my address I have not mentioned the phase of this subject which probably is of paramount interest to the heating contractor at the present time, and that phase is—What does an installation cost, and how much does it cost to operate? I have not gone into this subject for various reasons. In the first place, costs are not yet standardized and every proposition is a separate and distinct proposition of its own, and the costs may be anything from a few dollars to several thousand. With a proper knowledge of the right-sized equipment and of what the equipment should perform, apparatus may be selected and installed which will not add materially to the ordinary cost of indirect heating.

As far as cooling goes, all of the electrical cooling devices now on the market are too expensive to install and to operate for general use. However, methods of obtaining refrigerating effect cheaply and methods of operating cheaply are receiving the attention of many people and it should not be long before a sensible balance between benefits and cost is arrived at.

Today, any number of people are working on methods of developing refrigeration by means of steam jets. These fit in extremely well with the knowledge and ability of the heating contractor. They add beautifully to his regular installation practice and often have economies greater than electrical refrigeration. Where central heating systems are part of the city's service, this type of refrigeration can be installed with marked benefit to the utility's load and of great benefit to the heating contractor. Possibly this method of refrigeration will revolutionize the type of heating installation so that the heating boiler may be operated automatically during the summer time to generate the steam required for cooling purposes. I look with great favor on steam-developed refrigeration as one of the great potential businesses of the heating contractor.



The question arises as to why this was not thought of and developed before this. That question is easily answered. Refrigeration has always been considered in the light of ice-making, and ice-making contemplates temperatures out of the range of steam vacuum cooling. It was only when the moderate temperatures required for cooling became an important factor in comfort that this rather old method of producing cooling effects was developed for the new art of air conditioning.

Heat Generation and Distribution in an Industrial Building

By A. T. NORTH

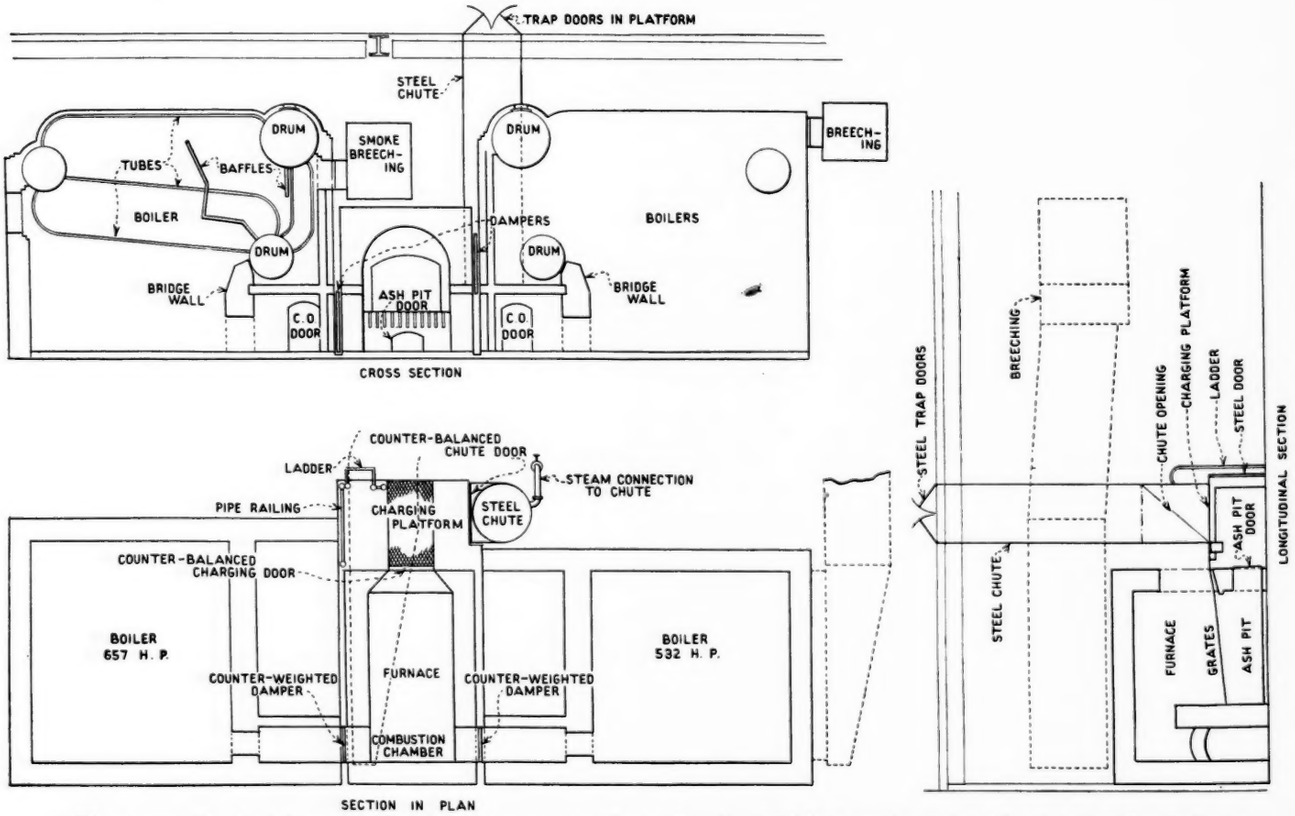
In the July issue the system of temperature control in the Starrett-Lehigh Building was described. In the accompanying article the author tells how the unit heaters are arranged in the same building so as to secure flexibility in connection with changing subdivisions of space. He also explains the method of supplying heat to the building from boilers which burn waste products.

A BUILDING that is intended to fulfil the requirements of a heterogeneous group of manufacturers presents some unusual problems to both the architect and the engineer. The requirements involve not only the architectural and structural design of the building, and service equipments for heat, light, power, elevators, and sanitation, but also economic advantages to the occupants. In designing the Starrett-Lehigh Building[1], New York, the architects and engineers were confronted with such a problem.

This building is designed for the tenant use of that class of manufacturers which constitutes 97% of the total number of manufacturers—the class that employs less than 250 persons each and requires 100,000 or less square feet of floor area. The necessity of economical housing and servicing to this great number of manufacturers precludes their profitable ownership and operation of detached plants in competition with the advantages secured by occupying buildings of the industrial utility center type of which the Starrett-Lehigh Building is an example—advantages resultant from the intensive utilization of land, decreased cost due to the public utility method of utilizing the service features, and of superior rail, truck, and passenger transportation facilities.

The lower stories of the Starrett-Lehigh Building have floor areas of 124,000 sq. ft. inclusive of the spaces occupied by elevators, shipping and receiving space for trucks, toilets, stairways and other utilities located in the center of the building. The upper floors have smaller floor areas due to setting back the exterior walls from the property lines. These floors are so

[1] HEATING AND VENTILATING, July, 1932, page 41.



Diagrammatic sketches showing the arrangement for using the building waste as fuel for the heating boilers

planned that they can be sub-divided into rentable areas as small as 500 sq. ft.

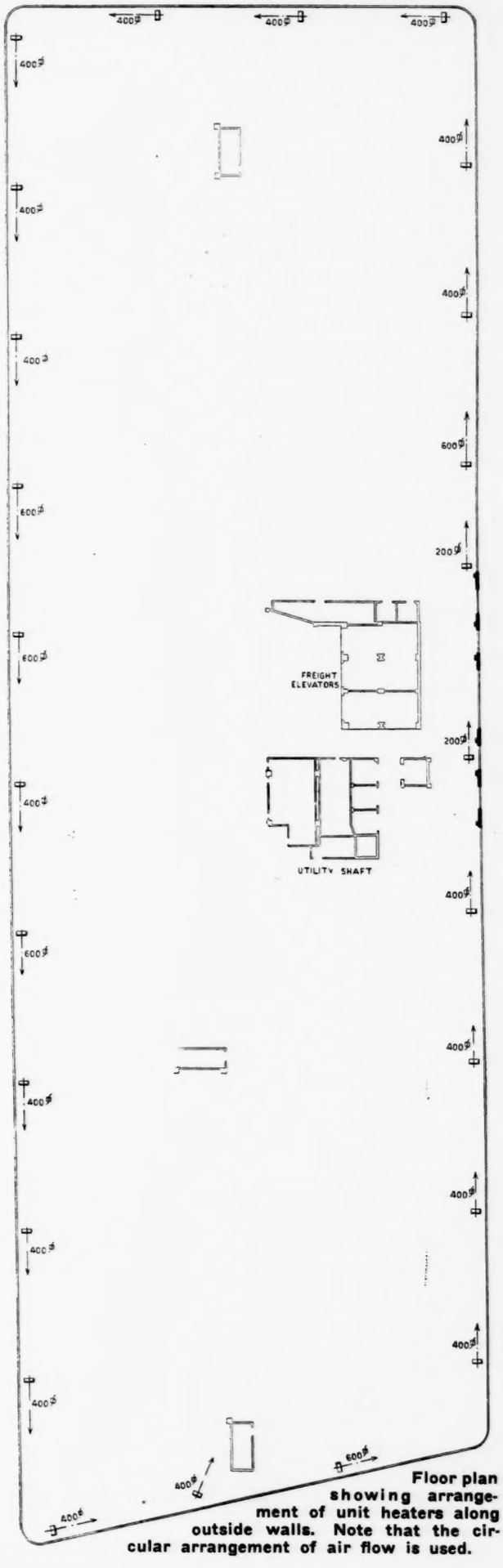
The primary requirements of the heating system are to heat adequately an entire undivided floor as well as to heat any sub-division thereof without making changes in the apparatus. Analysis of the problem indicated the use of unit heaters, and also, a certain distribution of them. There are no columns in the exterior walls which are supported by means of a cantilever floor construction from a row of columns some 8 ft. 9 in. therefrom. The unit heaters are suspended from the ceiling between this row of columns and the exterior walls, and are connected to the steam supply and return risers located at each fourth column, a spacing of about 60 ft. apart. Each unit heater will provide heat for about 6,000 sq. ft. of floor area. All of the unit heaters expel the warmed air in the same direction parallel to the exterior walls—in an anti-clockwise direction—westerly along the north wall and so on continuously around the building.

Where special conditions obtain as in the third story, auxiliary unit heaters are installed to compensate for the heat transmitted through the floor into the unheated second story which is used for garage space. The same precautions are used to compensate for heat losses through roofs and terraces at set-backs. Should it become necessary on account of an unusual subdivision of floor space to install a new unit heater at or to remove a unit heater to an adjacent column, the steam can be secured from the supply risers about 20 ft. distant through a supply branch with its corresponding return branch. This arrangement permits making any required change with minimum expense, and gives the greatest economical flexibility to the heating system.

Electrical ceiling outlets are installed at each column in this row to supply electrical current for unit heaters. Current can also be connected to the transformer in the thermostat cabinet to furnish the 20-volt current to the circuit that operates the device controlling the steam and power supply to the unit heaters. In general, each thermostat controls three unit heaters and with this electrical distribution thermostats and unit heaters can be installed at any of these columns as desired and the control circuit can be easily changed from one control thermostat to another to meet any special temperature requirement in a given area. It is apparent that adequate provisions have been made in this heating system for any possible contingency that may arise from the sub-division of floor areas for tenants.

Direct radiation is installed in the ground floor stores and restaurant, and also in the offices, barber shop, restaurant and emergency hospital located on the mezzanine floor.

Steam for heating is distributed at the ninth and eighteenth floors through low pressure horizontal mains to descending supply risers. This steam supply is divided into two systems, one for each half of the building. The main steam supply is brought to these floors at boiler pressure through an 8-in. riser to the ninth floor, and a 6-in. riser to the eighteenth floor. An 8-in. high-pressure riser extends to the eighteenth floor to supply industrial steam to tenants through branches at each floor as required. Provisions are



Floor plan showing arrangement of unit heaters along outside walls. Note that the circular arrangement of air flow is used.

made for installing additional industrial steam risers when required. The industrial steam return riser is connected into the steam heating system so as to utilize the flash steam, if any.

Oil is used for fuel in the Starrett-Lehigh Building. A street main extends from a slip in the North River through which the oil is pumped from tank barges to the oil storage tank in the building. This delivery service reduces the cost of oil and also the amount of street traffic that would be caused by delivery with motor tanks. Three boilers of the low head Stirling type comprise the steam generating plant. Electric current is provided from outside sources.

Temperature controls were inadvertently omitted from the List of Equipment in the Starrett-Lehigh Building, described by A. F. Hinrichsen and Chas. Hartman in "A Zoned Temperature Control System for an Industrial Utility Center," in the July issue. The controls were furnished by Stat-Amatic Instrument & Appliance Company.

In a building of this kind, occupied by manufacturers and merchandisers, there is naturally a large daily accumulation of waste combustible material, such as packing cases, cartons and wastes from manufacturing processes. The disposal of these wastes by ordinary methods usually is a source of considerable expense to the tenants. In this building the tenant delivers the refuse to his own shipping platform. The building operator transports it by elevator to the first floor and thence by a chute to the firing platform of an incinerator in the boiler room. This incinerator is located between the back walls of two boilers. There is a dampered opening leading from the incinerator into the lower part of each boiler. The hot gases of combustion generated in the incinerator pass through the dampered opening in the boiler setting, through an opening in bridge wall, and over grate bars and boiler tubes to the breeching in the usual manner. The saving in fuel consumption effected by the waste disposal apparatus is considerable, and it will increase until the building is occupied to full capacity.

The objectives of the architects and engineers of the Starrett-Lehigh Building, Messrs. R. G. and W. M. Cory, were to design a structure that would yield the maximum financial benefits to both the owners and the occupants: the owners to profit by the economical cost of construction, operation and maintenance of the building so adapted to the requirements of the tenant manufacturers that they also enjoy the maximum benefits which accrue from occupying this type of building.

* * *

Milwaukee Adds to District Heating System

ONE of the most important projects which have been undertaken by the Milwaukee Electric Railway and Light Company during recent years was the addition made during 1931 to the company's district heating system. The installation included the construction of 4300 ft. of tunnel, of which 4000 ft. is 6 ft. in diameter and 300 ft. of 7 ft. diameter. There is also a service branch 452 ft. long of 5 ft. tunnel.

The project was necessary to permit serving the Milwaukee County Court House which was completed last fall and also to provide additional capacity for the existing distribution system. The Court House, when entirely completed, will have a cubical content of 10,500,000 cu. ft.

The tunnel is from 30 ft. to 50 ft. below the street surface, and the major part had to be built under air pressure. The 14 in. high-pressure main installed in the tunnel is of sufficient capacity to provide for a five-year growth of the system on the west side of the Milwaukee River, which is the dividing line between the east and west side distribution systems.

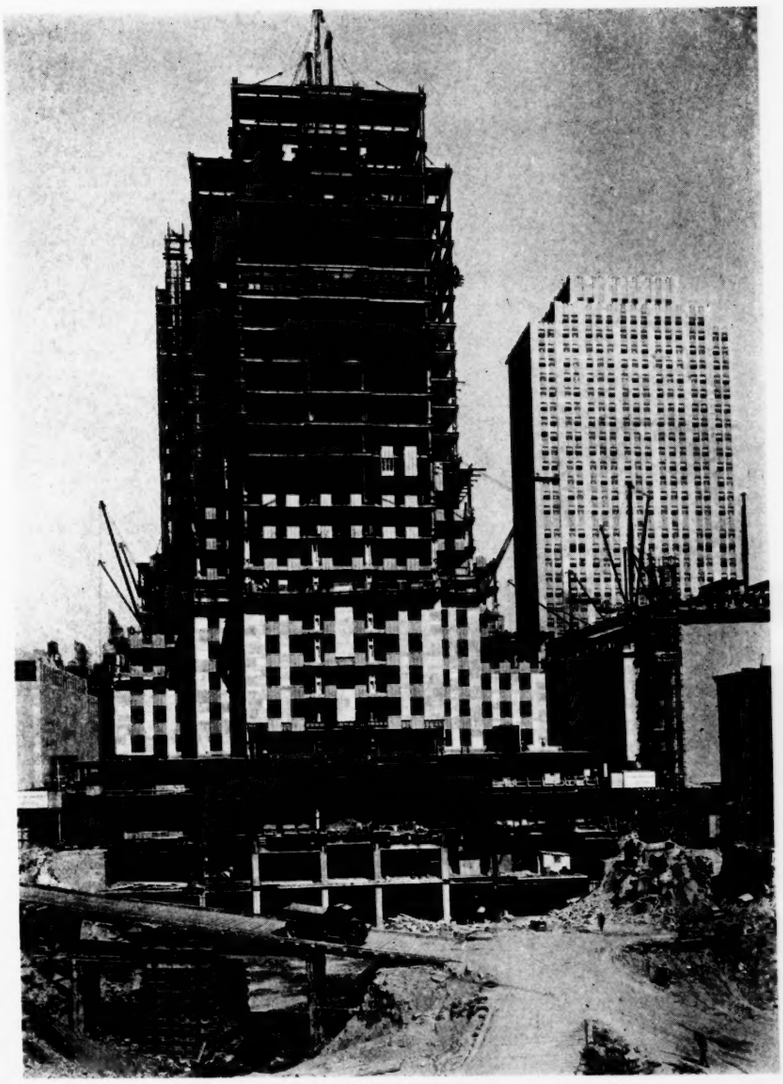
Under maximum flow the 14 in. main will pass 200,000 lb. of steam per hr. at a pressure drop of 125 lb. All piping is extra heavy and all joints are welded, no flanges being used excepting where valves are installed. The service lines to the Milwaukee County Court House are 8 in. and 10 in. in diameter. Since a pressure of 10 lb. must be carried, a long distance pressure recorder is installed to record at the plant the pressure that is maintained at the Court House.

Views in the new heating tunnel in Milwaukee

Rockefeller Center—IV

Design of the Air Conditioning System for the Broadcasting Studios

By A. WARREN CANNEY†



The 70-story building which will house N.B.C. as it appeared in July

THE series of articles appearing in current issues of HEATING AND VENTILATING which describe the heating and other air control equipment in Rockefeller Center are of particular value and interest not only because of the high calibre of the structures, the exceptional study given to planning, and the engineering which is at once both conservative and progressive, but also because of the intensive effort made by firms to present their product, service or ideas to those engaged in the development. In this way, Todd and Brown, management engineers, Reinhard & Hofmeister, executive architects, and Clyde R. Place, consulting engineer, who designed the system, have all received the benefit of the latest equipment, materials and methods available to modern building, largely as a result of the prominence of the project and the ebb in building ac-

†Of the Staff of Clyde R. Place, Consulting Engineers, New York.

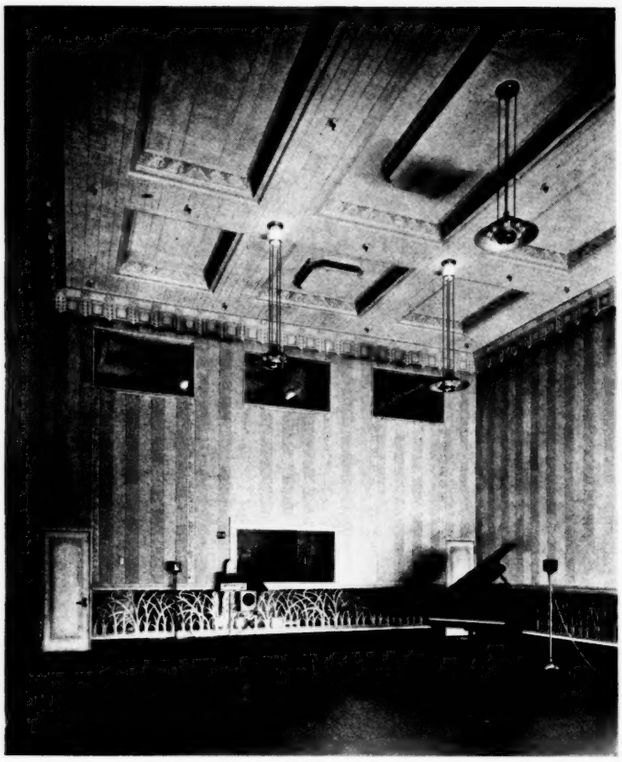


Fig. 1. Interior of Chicago broadcasting studio showing diffusion plates in ceiling

tivity. It is, therefore, safe to state that the individual mechanical equipments, whatever their service, crystallize ultra-modern practice sufficiently to indicate the trend.

The 70-Story Building

In the May issue of HEATING AND VENTILATING, the 70-story, central tower structure, referred to as Building No. 1, was described in general. The broadcasting studio section is contained in the westerly portion from the second to the 11th floors inclusive, with a roof garden over the 11th floor, and will be bounded by Office Building No. 9 to the west, Building No. 1 offices on the east, and 49th and 50th streets on the south and north respectively. The studio section, leased and operated by the National Broadcasting Company, will comprise 27 major studios and all the necessary auxiliary spaces for the production of continuous broadcasts over several channels and their allied networks. The responsible task which has been imposed on O. B. Hanson, technical director of N.B.C. and national radio authority, cannot be over-emphasized. Radio is in the throes of rapid advance and in cooperation with the architects and engineers, Mr. Hanson has incorporated the experiences of European, American, and especially the N.B.C. New York and Chicago studios, while planning a layout with full technical facilities which will efficiently execute the developments of tomorrow in the broadcasting field. Albert Baum of Jaros and Baum, retained by the National Broadcasting Company as its consulting engineers on air conditioning, has been actively engaged in assisting Mr. Hanson by cooperating to see that the system fullfills the N.B.C. requirements.

Description of Studio Section

There will be a large circular reception room for clients on the second floor. The third floor is planned for the combined reception and audition of broadcast talent, together with the operating program staff, such as musicians, announcers and pages, and those who receive clients and the public.

The studios proper are nearly all two stories high, with appurtenant rooms which create two functional levels. A studio unit, for example, contains on the lower level a control room, instrument storage room, frequently an artist's dressing room, and the necessary sound-lock entrance vestibules. Surrounding each studio on the upper level are the clients' observation room, clients' lounge and public observation rooms. Control, clients' and the public observation rooms are separated by large triple-glass partitions of special sound-proof design. Thus, studios occupying the double-story height of the fourth and fifth floors create two distinct functional levels, the lower for the musicians, artists, announcers, and studio engineers, and the upper level for clients and visitors. The layout of the seventh and eighth floors is similar to the fourth and fifth.

The sixth floor is devoted exclusively to the technical staff and electrical apparatus necessarily accommodated within the studio section. A few of the more important rooms on this floor are the main control room, booths for monitoring programs which originate outside the studio section, power and electrical equipment rooms, offices, maintenance shops, research laboratories and experimental studios. On the ninth and tenth floors there are studios one, two and three stories in height. Studios range in size from 3000 cu. ft. to 325,000 cu. ft.

Description of Air Conditioning System

A battery of refrigeration units in the sub-basement have a maximum cooler load of 900 tons in round figures. They reject condenser water heat to a cooling tower system on a unit-group pumping system. The towers are located 200 ft. above the ground, atop another building, and handle over 500,000 c.f.m.

All air-handling apparatus is on the 11th floor, where the chilled water is sprayed in the dehumidifiers. This apparatus is located between the three-story studio and the elevator machine room. The system employs 30 fans, with a supply circulation totaling 300,000 c.f.m., approximately, to 300 separate and distinct rooms.

One hundred and fifty supply and return air ducts penetrate the 11th floor in nine shafts having an area of 2% of the gross floor area of the studio section.

The design of the base scheme for the 11th floor apparatus employs centralized dehumidifying equipments with a network of distributing ducts averaging three deep at the 11th floor ceiling. An alternate tentative scheme involves decentralization of apparatus to effect a reduction in ductwork. In general, structural complications as well as the extraordinarily involved layout required have made careful planning necessary.

That the 11th floor represents the most complex air conditioning system within the confines of one apparatus room is not an over-statement. The net area of this room is about 25,000 sq. ft.

The major requirements governing design are tabulated as follows:

1. Maintenance of comfort in three types of spaces
   a—studios proper
   b—spaces used by artists, musicians and employees
   c—public space
2. Sound proofing and sound prevention
3. Control
4. Flexibility
5. Avoidance of and facilities for breakdown emergencies
6. Operating facilities

Requirements—Air Conditions

Every room in the studio section receives conditioned air, there being no general ventilation supply. In accordance with studio air conditioning experience, the entire plant is designed for the maintenance of a constant relative humidity throughout the year. A special floating wall, floor and ceiling soundproof construction is used, creating rooms within rooms, the combined isolation value of the wall being sufficient to render inaudible a sound of subway train intensity, were such a wall to act as a partition with the listener in an otherwise completely soundproof chamber. This construction, being thermally equivalent to 10 in. of cork, causes the studio section to be divided up into a honeycomb of so many refrigerators or thermos bottles, so to speak.

Under these conditions air conditioning becomes imperative because with high wattages for uniform illumination, the added wattage for decorative illumination and the concentration of population emitting double the heat and moisture of people at rest, ventilation alone is unsatisfactory. Not only is the loading high, but fluctuates in the individual spaces very quickly. For example, a large studio may be rehearsing a finale up to the last moment, with an orchestra of say 50 and a chorus of 40. Musicians work hard, and the total thermal pickup of the air is considerable. This studio may be emptied in two or three minutes leaving a piano team, an announcer ready for broadcast, and a client particularly sensitive to his climatological environment. Experience teaches that for best results an even disposition and an attitude of controlled composure on the part of artists is a vital necessity. It is realized that absolute quiet is required at all times and there can be no audible signals, or other errors, when "on the air."

Flexibility and Control

Extreme flexibility cannot be subjected in importance to sound level requirements, but is properly discussed here because of its relation to the maintenance of constant, accurately controlled air conditions. Each studio is under individual automatic control, as are all the clients' and public observation rooms, in order to compensate for the individually fluctuating loads which vary independently between no load and maximum. Control of the remaining spaces is grouped on a functional basis. This is to say, those spaces within the zone served by a given apparatus-type which have similar coincidentally fluctuating thermal loads are grouped on one control. Spaces which do not have stringent narrow-limit control requirements but which have either a large or a suddenly changing loading, also have individual control.

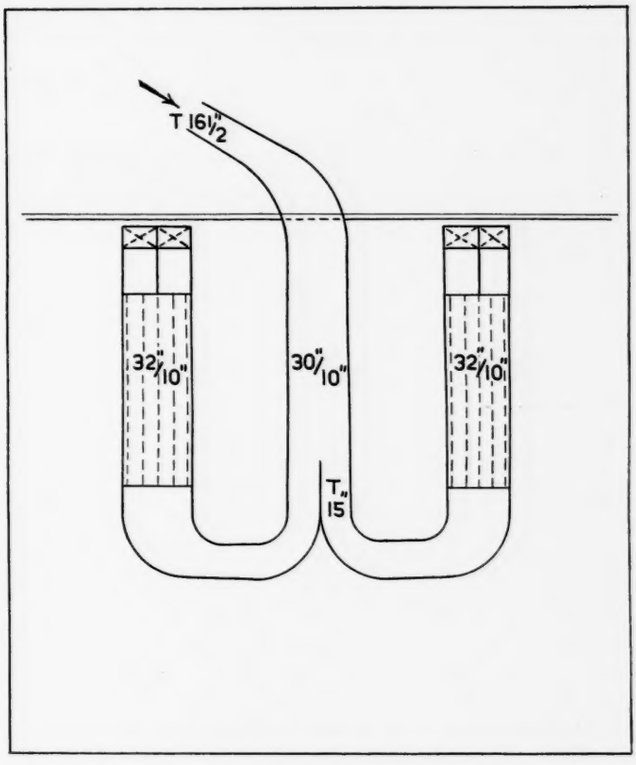


Fig. 2. How ducts are extended and turned back in order to get enough straight duct in which to insert the required length of sound absorbing material

In general, five types of control are used for room dry bulb temperatures; namely, return air pneumatic, supply air pneumatic, room thermostat pneumatic, room thermostat electric and manual outlet volume control. All client rooms and public observation rooms (excepting five observation rooms) have electric reheater control. The five excepted rooms are very large and have pneumatic control. The electric heaters are in the supply ducts near the spaces served and are so wired that they cannot receive current unless the fan motor serving their particular duct is running. There are 39 such spaces under automatic electric temperature control.

All exterior wall heating losses are taken care of by direct radiators under automatic compressed air control. Hence, with the exception of summer requirements necessitating refrigerated spray water, performance is much the same throughout the year.

The only spaces having windows are the offices along the north and south sides on the third and sixth floors. Special provision is made in the design to prevent window condensation in cold weather, an annoyance which would have to be tolerated were the relative humidity in these spaces not lowered from that required in the studios.

Sound

The sound-proofing and sound elimination requirements frequently dictated the shape, position and location of ductwork and received equal consideration with

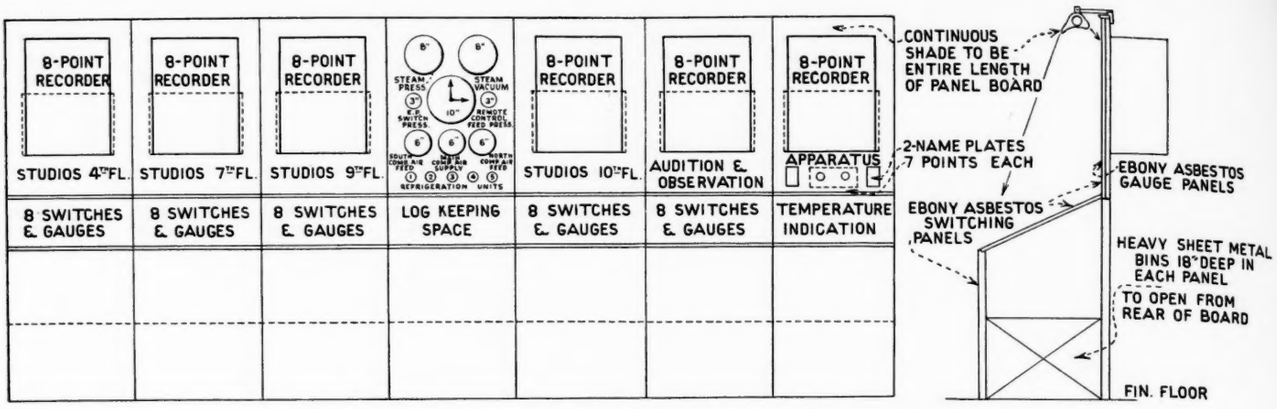


Fig. 3. Elevational drawing of the central operating control board

the air conditioning results. The swiftly developing technique of radio broadcasting has given impetus to many engineering fields in addition to the electrical. Control of sound in a building is one of them, and in this instance sound control is required to prevent interference and to eliminate or silence extraneous sources before sound reaches the super-sensitive microphones.

The inherent ground noise or minimum sound level in the electrical equipment from studio to antennae has been reduced to an unbelievably low level. The effect of sound, particularly noticeable at low levels, is that a sound of a given absolute intensity becomes seemingly of greater intensity when the sound level in which it is produced is lowered. Consequently, the creation of rooms which "extract" so much ordinary noise that the sound level is just above the threshold of audibility, a slight air rush sound—due, let us say, to the friction of air flowing in a duct—has the effect of being intolerably loud. This is partly due to the fact that the sensitivity of microphones has been increased, and they readily pick up sounds of so low intensity as to be undetectable by direct listening. The previously mentioned highly efficient sound-proofing to prevent sound transmission into or out of each studio unit, in addition to other factors, called for cautious design in excess of that required in older broadcasting installations. For example, special tests have been made on various materials and application methods in order to improve past practice in absorbing sounds within the ducts. Every test involved attenuation measurements at forty different frequencies. A higher and flatter absorption characteristic, especially at lower frequencies, has been obtained as a result of these tests.

The need for treatment is due, in the main, to two sources. First, the lowering of the isolation value of the construction from that which would obtain were no ductwork to pierce any of the construction, and second, sounds originated by the air conditioning system itself. These resolve, in general, into 10 detailed classifications as follows:

1. Apparatus noise conveyed through the ducts, much as in a speaking tube.
2. Sounds created by the friction of air
   (a) on the sides of the ducts
   (b) passing apparatus interposed in the ducts
   (c) passing over sharp edges, particularly near outlets and return grilles.
3. Sounds created by undue turbulence due to excessive velocities from sharp turns near outlets and return grilles.
4. Foundation vibrations of apparatus.
5. Sound picked up by the sheet metal of the ducts and transmitted to some point of contact with the soundproofed walls.
6. The lowering of the sound insulative value of the construction where ducts pierce the construction.
7. Transmission of sound through one duct to another duct connecting another room.
8. Transmission of sound through duct shafts.
9. Transmission of sound from one room to another through the branches of a common duct.
10. Vibration in piping or other equipment supported by the structure proper.

The installation has been designed in such a way that in rooms requiring low sound level or avoidance of disturbances, Item 9 has been the rare condition, and where this has occurred special precautions were taken.

In view of the foregoing considerations it can readily be seen that the matter of sound reduction becomes a major consideration of equal importance to obtaining proper distribution of the air.

The base design is such that the studios proper are served by exclusive equipments, there being five dehumidifying units for studios and five for all other spaces. Aside from reasons of air conditioning control and well balanced duct systems, the main reason for this division is one of sound level requirements, permitting higher velocities in the ductwork handling the miscellaneous spaces. Moreover, this keeps the studio ductwork segregated and permits of separate acoustical treatment without the danger of jeopardizing results by tie-in or interference from apparatus or sound sources not receiving such special attention.

The introduction of sliding panels for varying the reverberation period of the studios necessitated grilles 10 in. high by 10 ft. long in many instances, calling for especially designed streamline ductwork. All grilles in the studios are of special streamline design, as such close proximity to the microphones of even minute sound sources will produce trouble.

The importance of convenient facilities for the operation of such a plant has considerable influence on the design. It is necessary for the operator to have immediate access to the controls for changes in temperature settings of the thermostats. In addition, the

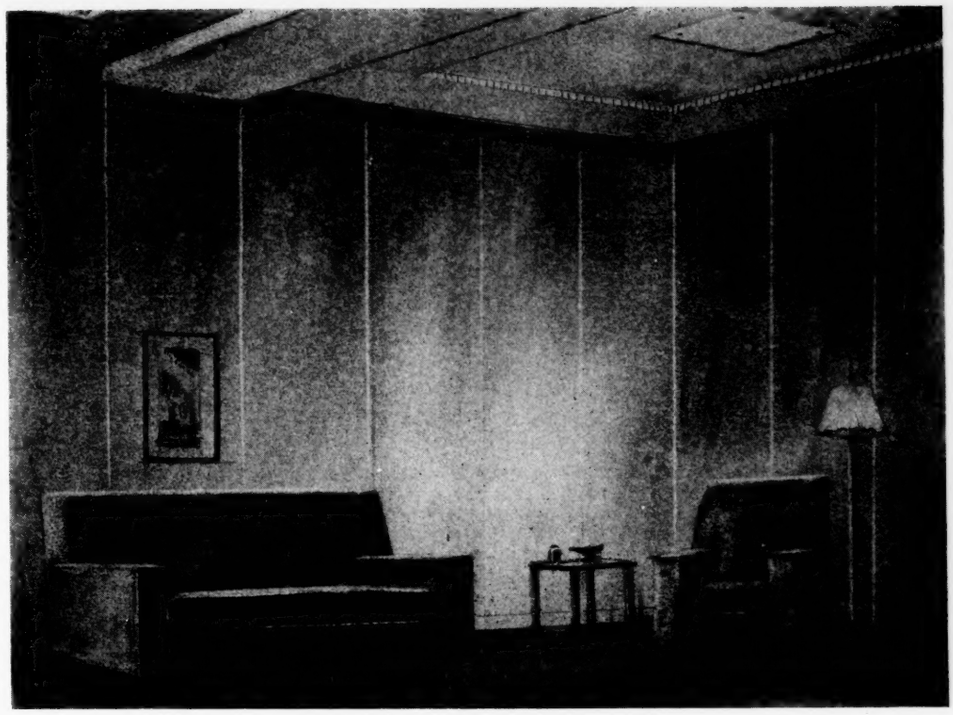


Fig. 4. Artist's view of side wall outlets near ceiling of foyers.

evident desirability of locating such vital equipment as the controls for ready access and maintenance, led to the location of all control facilities in the apparatus room, except electric room thermostats and their heaters. The quick correction of a complaint or the instantaneous adjustment of conditions more to the liking of an artist is deemed essential. To effect this, a specially designed, glass-enclosed air conditioning control room will be located in the center of the 11th floor apparatus room. Of the 78 return air pneumatic controls, nearly half will be provided with remote control from a control board shown in Fig. 1. Electric temperature recorders will provide permanent record as well as visual indication of the performance of all thermostats controlling room conditions, together with other important temperatures for a complete operating log. A system of temperature indication will provide a check on the performance of all electric controls. The necessary steam and air pressure gauges are located on the center panel below which is a space for log writing. Full supervision is thus possible from this one point, which will also be the operating engineer's office. Between this room and the stairways, specially provided, there will be a glass-enclosed observation foyer in order to display the 11th floor air conditioning apparatus and remote control room to the public.

The subdivision of the air ducts, the many spaces on each floor, large beams for two-story studio spans, wind bracing, extensive network of conduit circuits, the 8-ft. straightaway duct for sound absorbers adjacent to each supply and return outlet in the studio units, all resulted in a very complex air conditioning layout.

Some of the detailed features of the system may prove of interest. For the benefit of artists, particular care has been taken in the matter of smoke removal. A novel treatment in the smoking lounges, resulting from architectural requirements, consists of the exhaust duct connecting to a grille in the bottom of the ceiling plaque, which also serves for the supply deflector.

All of the air delivered is filtered, the outdoor air receiving the additional cleansing action of the sprays.

Fans were selected with more than ordinary care for performance, in addition to meeting the degree of quietness required, as the 11th floor is directly over the studios. Some of the systems use partial volume control, the supply ducts being run down from a constant pressure chamber on the supply fan discharge. These fans were selected to operate within narrow limits of pressure variation, with a change in resistance resulting from changing volume.

Some of the other fans were selected for constant volume of delivery within calculated limits of variation in system resistance, these fans operating in parallel on the dehumidified air suction side.

The acoustical material used for interior finish in rooms comprising the studio units is highly porous and subject to smudging. Therefore special ceiling plaques were designed to eliminate the unsightly streaking commonly observed at air-delivery room outlets.

Distribution in the foyers will be accomplished by side-wall outlets feeding horizontally near the ceiling. Instead of the usual grille, a continuous louver effect will completely conceal the presence of these outlets. An idea of the effect may be gained by reference to Fig. 4.

In keeping with modern building practice, more attention is being paid to quietizing. For this reason, solid doors were interposed in the corridor doorway connecting the toilets and the foyers.

While based on established practice and experience, this system is noteworthy not alone because of its complicity, nor because it will be one of the most extensive air conditioning systems ever built under one contract, but because it marks the best that air conditioning can be made to do under the most stringent requirements yet imposed on an air conditioning system as a building service, which are just about as exacting as can be conceived for air conditioning as we know it today.

Degree Day Base Figures for Different Type Buildings Heated with District Steam

THE amount of heat required by a building depends upon the outdoor temperature, other things being equal. Theoretically, it is proportional to the difference between the indoor and outdoor temperature. Some years ago a unit known as the degree day was originated by the gas industry for estimating fuel consumption at different outdoor temperatures. It is defined as a difference of 1° between the base temperature and the mean outdoor temperature for a day. The number of degree days in any period is the summation of the differences between the base temperature (65° F. for the standard degree day) and the daily mean temperature below 65°.

The base of 65° for the degree day was originally chosen because it was found that the amount of gas required for heating residences was proportional to the difference between 65° and the outdoor temperature. The degree day is now rather widely used for other methods of heating and for other types of buildings. In order to obtain more information on the relation between the amount of heat required by buildings and the outdoor temperature, the association was asked to cooperate with other organizations in collecting data. This committee sent forms to all member companies requesting the steam consumption for individual buildings by months for a heating season and also the average outdoor temperature by months. The American Gas Association and the American Oil Burner Association have been collecting such data from their members, and HEATING AND VENTILATING has undertaken to get similar information on electrical heating and on the use of coal and coke residences.

Data were collected from 175 buildings[1] in 22 cities. The results were arrived at as follows: The steam consumption of each building by months was divided by the number of days in each month, thus giving the average daily steam consumption by months. The average steam consumption was then plotted against the average monthly temperatures, as shown in Fig. 1, and the temperature at which a line drawn through the points crossed the line of zero steam consumption was noted and listed in Table 1[2]. In Fig. 1 the line crosses zero at 65.6° and it is obvious that the steam consumption at any lower outdoor temperature is proportional to the difference between that temperature and 65.6°. In every case the relation between temperature and steam consumption was a straight-line relation, although in many cases the points were scattered more than in Fig. 1. In general, the buildings in which the temperature was carefully regulated gave the most orderly results. The building from which Fig. 1 was plotted is well operated during the day, and steam is shut off at night.

[1] These were district steam heated—Editor.
[2] Not reproduced here.

The figures as calculated show that for office buildings heated with district steam, the amount of steam used for heating is proportional on the average to the difference between 66.2° and the outdoor temperature. For the stores the average base temperature is 64°, and for the department stores it is 64.3°. The base temperature is lower than for office buildings probably because of the smaller number of heating hours per day. For the apartments the average base temperature is 68.8°, probably because of long-hour use and high indoor temperatures. One storage garage in which the indoor temperature is kept at 55° has a base temperature of 56.5° indicating that the base temperature approximates the average indoor temperature. The base temperature for the auto sales and service buildings is 61.2° which probably represents the average temperature in these buildings in which an office is heated to 70° and the larger part of the building is at a lower temperature.—*From the Report of the Commercial Relations Committee National District Heating Association*, 1932.

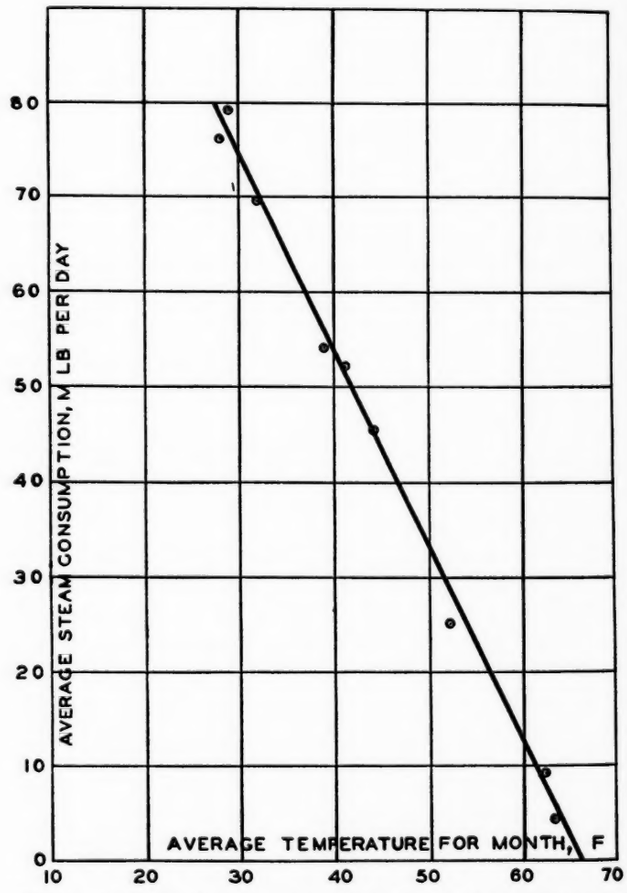


Fig. 1. Average steam consumption for building heating vs. outdoor temperature, 40-story Detroit office building

Making the Rounds with a SERVICE *Man*

Part IV

By
V. D. Milliken

The next job which Doc and Mac serviced was a long, one-story factory building. The boiler room was located at one end of the building, and the offices were in the opposite end.

* * *

"The report on this job says that the boiler is almost constantly flooded with water and that at times some of the radiators in the office are cold," said Doc.

"That sounds like a duplication of the last job we were on," replied Mac. "An equalizing connection should fix that up too."

"There is a surprise in store for you here, Mac," said Doc, as they entered the boiler room. "Just glance around and then express yourself any way you like."

"Well, I'll be darned!" exclaimed Mac. "There *is* an equalizing connection on this job."

"Yes, I heard that it had been installed. Notice that it is installed correctly, too, but don't lose faith in it."

Mac was indeed puzzled now. He noted that the boiler pressure at that moment was twelve pounds. The vacuum pump had just stopped, having pulled a seven-inch vacuum on the return line. The return lines were not excessively hot, and the system seemed to be working perfectly. He had learned, however, that the system should be subjected to all operating conditions and, therefore, prepared to shut the oil burner off.

"We had better talk to the engineer first," advised Doc. "Sometimes they are pretty fussy and don't want anyone meddling with their pets. I want to show you something at the other end of the building, and while we are walking about we'll look for the engineer."

They walked along the wall, examining the return line. Presently they came to a wide door through which trucks could be driven to pick up and deliver materials.

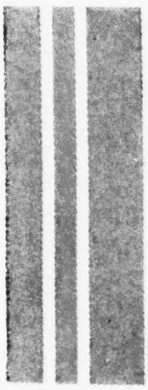
"Here is what I wanted to show you, Mac," said Doc, pointing to the return line which had been dropped under the doorway. "You see, the return line drops down on this side of the door, and is brought up again on the other side so that trucks may drive in and out freely. The condensate will run under the doorway, but the air will be trapped even when lift fittings are used, if the vacuum pump is operating on float control. Therefore, an air loop should be installed. The air loop is connected to the return line on this side of the door and extends upward, over the door and down on the other side to the return line over there. Then, both air and condensate will pass the door."

"That is the reason for lack of heat in the office, isn't it, Doc?" inquired Mac.

"That's it. You probably have noticed that this return line extends into the office. With the line trapped, there is naturally poor circulation."

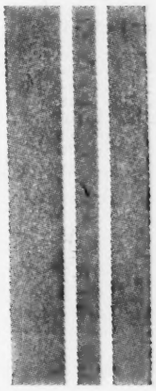
Mac carefully sketched the air loop layout, for Doc had advised him to keep a note book for preserving kinks and other useful ideas which come to his attention.

During their inspection trip, they met the engineer who accompanied them back to the boiler room. He was instructed to operate the system in the same manner as when the trouble occurred before. The oil burner was shut off, and the vacuum pump was switched over to float control. It seemed an eternity to Mac, who was eager for something to happen. The vacuum pump



What Has Gone Before

Doc White is the service engineer for a large heating contractor. He recently engaged a new assistant, McKay, who has had no practical experience with steam heating systems. Mac has had explained to him the elements of vacuum heating, learned how to locate a leaky return line, and has learned the value and use of the equalizing line.



tripped in twice on float control and discharged the contents of its receiver to the boiler. Finally, the compound gage on the boiler passed the zero mark and indicated a vacuum.

"Now, Mac, let's watch the vacuum pump like a hawk, only this time, watch the level of water in the accumulator tank as well as the vacuum gauge. There is a four-inch vacuum at the pump and the vacuum on the boiler is increasing."

Presently, the pointer on the vacuum gauge quivered, accompanied by a gurgling noise. "There goes the equalizing connection," exclaimed Mac. He was alert now and had forgotten about his long wait. Again and again the increasing vacuum on the boiler was relieved through the equalizing connection until at last it was at a standstill.

"The vacuum on the boiler and also at the pump is now six inches," explained Doc, "and the accumulator tank is about three-quarters full. The vacuum on the boiler apparently is not going to increase any more, and as a consequence, will not aid us in filling the tank so the pump will start on float control. Furthermore, the traps are cool now and undoubtedly the vacuum is identical at all points. It is also reasonable to presume that there is a lot of condensate stored in that long return line out there, because enough time has elapsed to condense several tankfuls of condensate. The problem is to get that condensate out here to flow into the accumulator tank. How shall we do it?"

"You've got me up a tree, Doc," replied Mac. "If the inlet connection on the pump were higher than the return line, I can see that the whole return line might become flooded to a height corresponding to the level at which the float-operated switch starts the pump, but the inlet connection on this pump is low enough to permit gravity flow. Why doesn't the condensate flow into the tank?"

"I'm going to make you answer that question by asking you a few questions. Have you ever noticed that S-shaped fitting that is installed on the drain line of all kitchen sinks?"

"Yes, I have," replied Mac.

"And have you noticed the air struggling to get out of a narrow neck bottle when you fill it with water?"

"Yes," replied Mac.

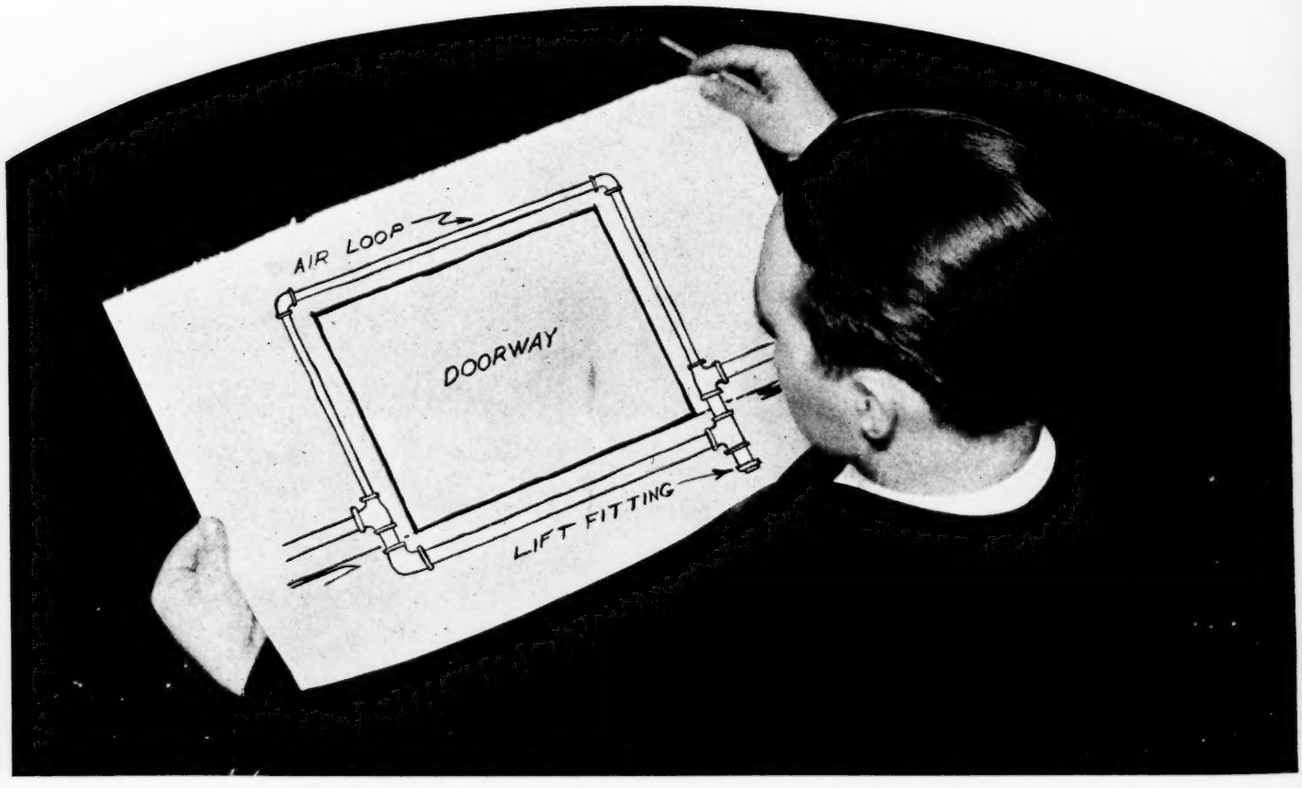
"Fine," continued Doc. "The S-shaped fitting is a trap which permits water to flow from the sink to the sewer, but which prevents any foul odors from the sewer from entering the kitchen. In other words, water will pass through such a trap, but air will not unless there is sufficient pressure to overcome the head of water in the trap. I mentioned the bottle to remind you that as water enters a container the air is displaced, otherwise the container is air bound and no water will enter. Now, keep that in mind when I tell you that practically all strainers furnished with vacuum pumps are so constructed as to trap the return line in the same manner that the S-shaped fitting traps the kitchen sink. Now think of the bottle again. Water may enter if air escapes. Get the idea?"

"Not exactly," replied Mac. "Surely the air can escape through that air displacement valve."

"It could if it weren't for the vacuum which holds it closed," said Doc, smiling.

"Check and double check. I see it now. The accumulator tank or receiver is air bound."

"Exactly," replied Doc. "Air bound under vacuum. The air can't escape because of the seal in the strainer



Mac sketched the air-loop arrangement for his note book.

and, consequently, no condensate can enter. Furthermore, a leakage of air into the accumulator tank will make matters worse, because the vacuum in the receiver will become lower, with the result that the condensate will tend to flow away from the pump instead of toward it."

"I believe I understand that thoroughly now, but how do you eliminate this trouble?"

"Again you will have to answer your own question," replied Doc. "If you wanted the foul odors from the sewer to enter your kitchen, what would you do?"

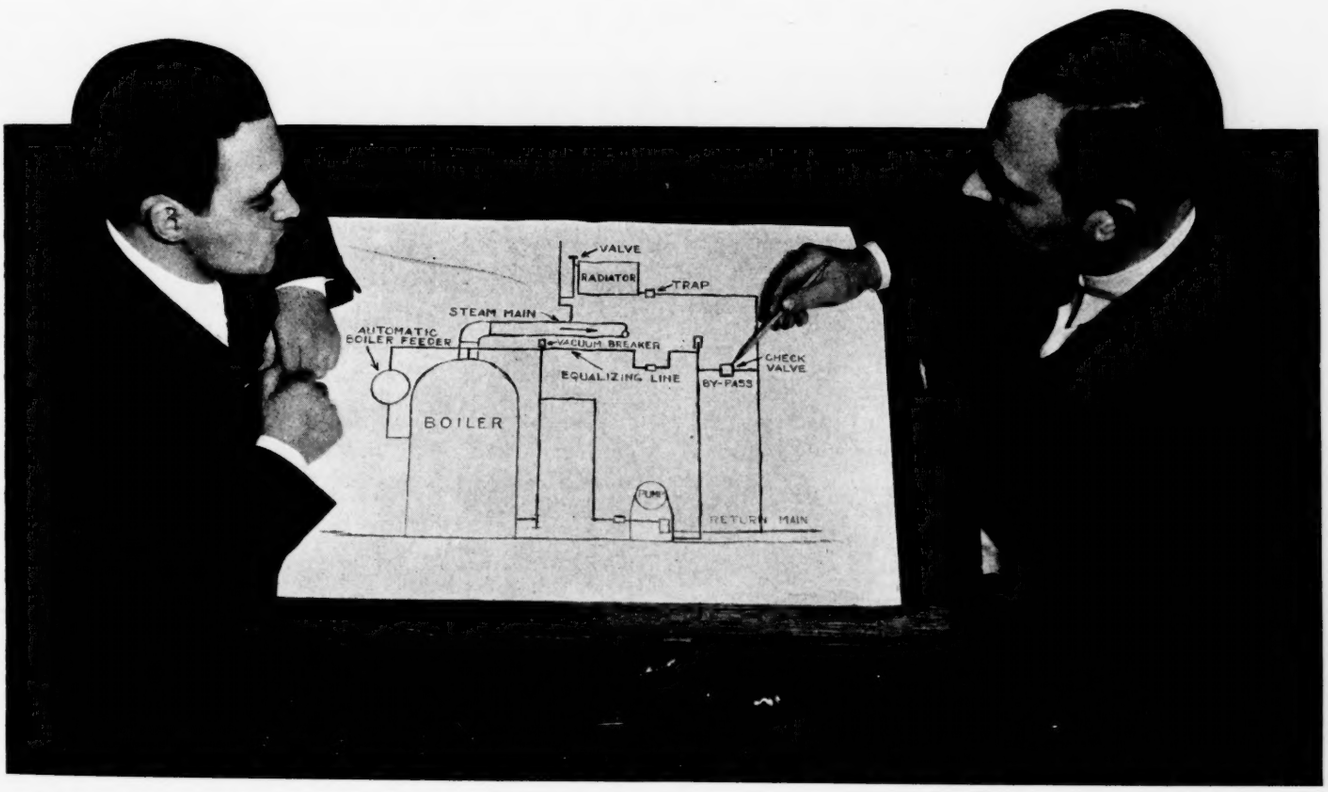
"Why, I would install a by-pass around the—well, I'll be a son-of-a-sea-cook!" exclaimed Mac. It's as simple as pie, with you asking questions to stimulate the old noodle."

They seated themselves at the table that served the engineer for a desk, and Mac hurriedy made a diagram of the system on a piece of wrapping paper.

"I guess you've got it now, Mac, but when you connect the by-pass line from the accumulator tank to the return line, be sure that it is to the dry return, or at least to a riser at a point above the water line in the boiler. In this case, we can connect from the equalizing line to that riser. The equalizer line is connected to the accumulator tank and we can break the return riser above the water line in the boiler, and connect the other end of the by-pass at that point. Then the air will be forced into the riser and permit the condensate to enter the receiver. I get rather careless in referring to the accumulator tank, the receiver, the hollow base, or the interceptor base, but they all serve as a reservoir and are named differently by the several manufacturers. The troubles and methods of correcting them apply, in general, to most makes of pumps."

"The connection which you propose making on this job will eliminate flooding of the boiler, just like it did on the last job, won't it?" asked Mac.

"No, it won't," replied Doc. "The automatic boiler feeder on the last job was installed correctly, but this one is not. On the last job, the water line in the boiler became low enough to operate the boiler feeder and admit additional water. Then, when the condensate, which had been held up in the radiation due to vacuum on the boiler, finally returned to the pump and was discharged to the boiler, the boiler became flooded. On this job, however, the boiler becomes flooded when there is a pressure on it. Your first thought might be that the boiler feeder valve is dirty or stuck, thus permitting water to enter the boiler. That is unlikely to happen in this case, however, because this particular boiler feeder has its water valve protected against temperature. By that I mean that the temperature of the water surrounding the valve cannot become sufficiently high to cause the lime in the water to precipitate, thus forming the same kind of scale which forms in a tea kettle. The trouble here is due to improper installation. The boiler feeder, like the water column, has equalizing pipes connecting into the boiler above and below the water line. The lower equalizing pipe on this feeder is connected into the bottom of the boiler. At this point in the boiler, the cross-section which contains the water is very narrow. Next to the surface which is exposed to the fire, there is naturally an upward current of water, while along the cooler surface of the outer wall, there is a downward current of water. This current is often great enough to cause the water in the lower equalizing pipe of the automatic boiler feeder, and also in the float chamber of the feeder, to lower. Once



"Be sure that the by-pass connects to the dry return or to a riser at a point above the boiler water line."

lowered, the valve is opened and water is admitted to the boiler. The remedy for this condition is to connect the lower equalizing pipe of the boiler feeder into the boiler at a higher point. The best place to connect it is naturally at a point above the narrow section."

"Are there any other conditions which might cause a flooded boiler, Doc?"

"A priming boiler could cause it, if the boiler was equipped with a boiler feeder. With no boiler feeder on the boiler, the water line would drop," replied Doc.

"What happens when a boiler is priming?"

"The water line is generally very unsteady in the water gauge glass," replied Doc. "The cause of priming is generally due to the presence of oil or similar foreign matter in the water. You can generally detect its presence by the usual colors reflected from a film of oil in the gauge glass, or on the surface of a sample of water removed from the boiler at the water line. Oil forms a film over the entire surface of the water, and since the surface tension of this film is quite great, the bubbles of steam which rise to the surface of the water meet resistance. The result is a multitude of minute explosions at the surface, causing droplets of water to be carried into the steam mains by the liberated steam. The result of this is naturally a lowering water line in the boiler. If a boiler feeder is installed, additional water will be admitted to the boiler, and then when the water, which was ejected by the priming action of the boiler returns to the boiler, it becomes flooded."

"I have certainly learned something on this job, Doc. Where do we go from here?"

"Our next stop is at a job where the pump is reported to be noisy," replied Doc.

[*In the next installment Doc describes some excellent methods by which transmission of noise is eliminated.*]

* * *

Cooling Coil for Hot Condensate Returns

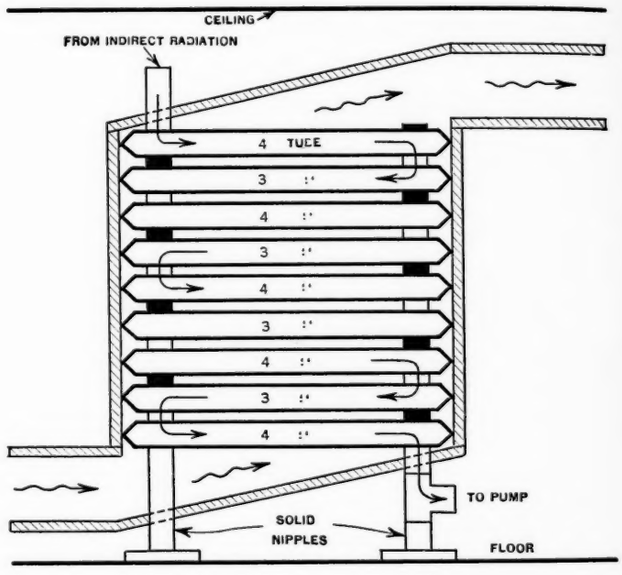
WITH indirect radiation exposed to cold air and designed to be operated with pressures above those ordinarily used, cold air striking the heating surface sometimes produces a vacuum and causes a portion of the condensate to be held in the heaters. Complete drainage is difficult unless a vacuum return line is used with a vacuum of about 15 in. maintained in it. The vacuum is difficult to maintain owing to the condensate being too hot for the pump to handle.

One solution of this problem is to install an additional amount of surface across the return line to cool the condensate and to permit it to flash into steam, thus taking heat from the remaining condensate and cooling it. However, the amount of surface that is required to be installed for cooling sometimes exceeds the space provided for the installation.

An ordinary cast iron radiator is unsuited for this work, since the condensate takes the shortest path from the inlet to outlet, so that a large portion of the surface is by-passed.

The accompanying sketch shows how an efficient cooling coil radiator may be built from ordinary right and left tapped radiation. This radiation when encased provides an economizer in the cooling of the condensate. The black blocks denote plugged or solid right and left nipples and the white blocks at the other end of the section denote regular right and left nipple. The arrows show the flow of condensate from section to section.

Assume that one bank of radiators is to be used, as shown in sketch, and further assume that tubular radiators are selected. The air flow is shown by wavy arrows in sketch. The 4-tube and the 3-tube radiator used alternately, as shown in sketch, from the bottom to the top of the heater would provide good width and force the air to flow over all of the heating surfaces.



The cost for cooling will depend somewhat upon the contractor's shopping acumen at second-hand shops or what he may be able to salvage from his own reclaimed stock.

There are certain desirable features to be sought for in selecting the materials for use in the housing and heater. The housing may be constructed of rough boards and lined with tin or galvanized sheet iron, simple and direct in design, with holes cut for pipe connections and stand, although screwed angle iron corners or simply hook and eye connection make for easy removal of sides for inspection and cleaning. Regardless of the construction, the builder should strive for a tight fitting, compact, and rugged casing.—*William Anderson.*

Air Conditioning

XXI—Conclusion

By WILLIAM HULL STANGLE
and
REALTO E. CHERNE†

IN the preceding twenty articles of this series on Air Conditioning, fundamentals and general details of design have been covered. It is the purpose of this concluding chapter to correlate the material that has been presented in order that a routine may be formulated for the systematic design of an air conditioning system.

Definite information must be obtained as to the design of the building, its occupancy, use, magnitude, and the seasonal climatic conditions of the locality. The conditions incidental to each building and each locality warrant a careful and comprehensive study to produce the desired results within economic limits. For example, an air conditioning system designed for a New York office building would not give the desired results in a similar building in Phoenix, Ariz., for the climatic conditions are so widely at variance. The difference in cost of the systems is usually of such magnitude that it is advisable carefully to engineer each project as a separate entity. In other words "rule-of-thumb" methods of capacity calculations cannot be applied to the design of air conditioning systems.

The first thing to consider in making an initial study of a project is the amount of heat gained or lost during the most severe operating conditions. For a study of the heat balance it is necessary to know the amount of glass, wall and roof exposure, number of occupants, and the amount of heat given off by illuminating and other equipment within the conditioned areas. This summation can only be made by a careful survey of the plans for the specific project. Heat loss, constants, temperature differentials, and the like, can be obtained from handbooks. The correct application of these physical data is dependent upon the experience of the designing engineer. The object of careful calculation is to enable the engineer to select a system of sufficient and proper capacity to produce the desired result in the most economic manner. Any number of systems can be designed to produce a desired result, but only one will be most economical to own and operate.

As has been previously pointed out, air conditioning equipment is generally selected on the basis of the summer cooling load. In all but rare cases, such equipment will have more than enough capacity for winter operation. However, should it be necessary to design a system with winter heating and humidification as the principal objective, it is necessary to base the air capacity on a consideration of the total heat loss under the most severe conditions and the minimum air supply that will give good distribution.

The second thing to consider is the type of occupancy of the building—whether it is an office building, hotel, theater, restaurant, apartment, or residence. This is necessary so that the proper type of equipment and economic limits of capacity can be determined. For example, if a system is to be used for

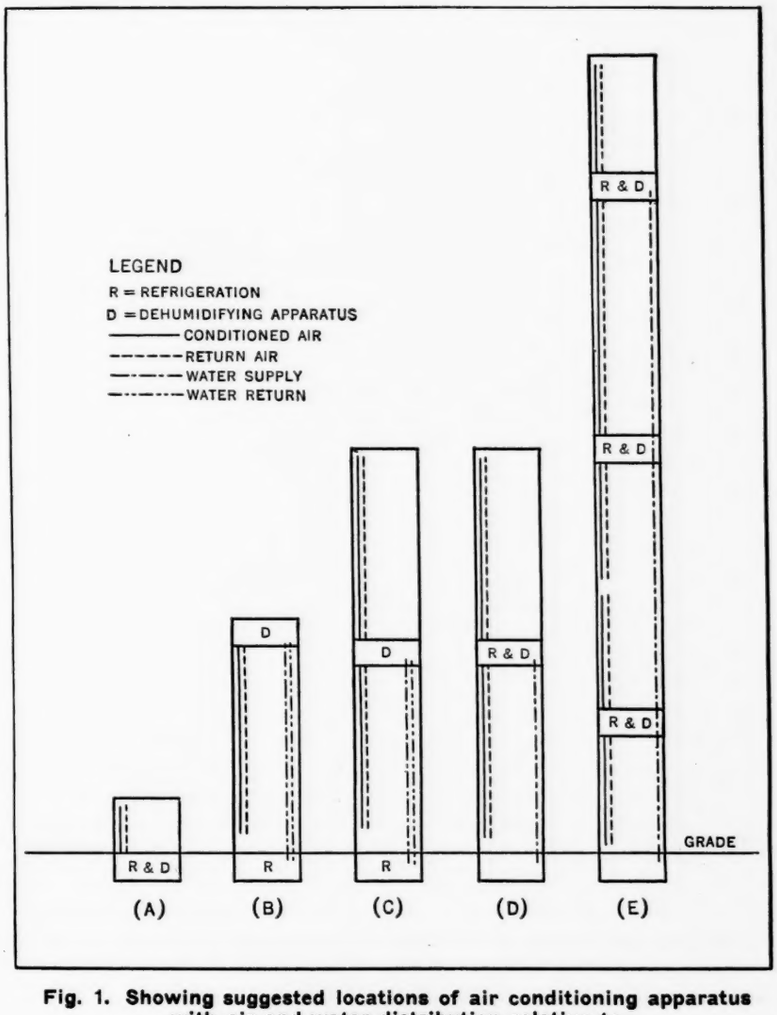


Fig. 1. Showing suggested locations of air conditioning apparatus with air and water distribution relative to heights of buildings.

†Carrier Engineering Corporation.

but 2 hr. or 3 hr. per day, it may be proven advantageous to install a cold water storage tank and a small refrigerating machine, rather than to install a refrigerating machine of instantaneous sufficient capacity which would be idle for the remaining 21 hr. or 22 hr. per day.

The third point is type of air distribution. The size and location of outlets which will give the proper diffusion of the air without drafts or noise must be determined. Size and location of branch ducts must be consistent with architectural requirements as well as the outlets which they service. Main ducts or trunks are generally located so as to utilize available utility space rather than rentable areas. Quite often the type of distribution is made secondary to the available location for duct work. This condition has brought forth many types of outlets to meet the requirements of unusual space limitations, architectural treatment, and air diffusion.

FOLLOWING ARE THE SUBJECTS COVERED IN THE SERIES ON "AIR CONDITIONING"

I—Preamble, June, 1930.
II—Ventilation—General Discussion, July, 1930.
III—Ventilation—General Discussion, August, 1930.
IV—Ventilation—Diffusion, October, 1930.
V—Fan Design, November, 1930.
VI—Fans and Drives, January, 1931.
VII—Air Distribution and Duct Friction, February, 1931.
VIII—Outlets and Inlets, March, 1931.
IX—Atmospheres and Psychrometry, May, 1931.
X—Body Heat Losses and Comfort Charts, June, 1931.
XI—Apparatus, July, 1931.
XII—Apparatus, October, 1931.
XIII—Apparatus, November, 1931.
XIV—Mechanical Refrigeration, November, 1931.
XV—Mechanical Refrigeration, January, 1932.
XVI—Water and Steam Piping, February, 1932.
XVII—Automatic Temperature and Humidity Control, March, 1932.
XVIII—Condenser Water for Refrigeration, April, 1932.
XIX—Fabrication and Erection of Ductwork, May, 1932.
XX—Heat Insulation and Sound Isolation, July, 1932.
XXI—Conclusion, August, 1932.

The fourth consideration is the location of apparatus. This is an item of paramount importance, for it is dependent upon the design and magnitude of the building and, if properly analyzed and designed, will result in real economy of cost and operation. In some instances first cost will be increased but more than offset by the lowering of operating expense. Fig. 1, a to e, will indicate some possible arrangements of locations for apparatus. Fig. 1a would apply to relatively low buildings, Fig. 1b to moderately tall buildings, say approximately 15 stories, Figs. 1c and 1d to taller buildings, say approximately 30 stories, and Fig. 1e to extremely tall buildings. It will be noted that common practice and experience have placed the dehumidifying apparatus together and near the fresh air supply, while the refrigeration equipment has been placed in the basement or cellar, because of its greater weight.

With the advent of more compact and lighter refrigeration equipment it often becomes possible to collect both the refrigeration and dehumidifying apparatus in one group (as suggested in Figs. 1d and 1e). It should always be borne in mind that the pumping head materially affects the operating cost.

Apparatus should be located both in elevation and plan to permit the most efficient and economical circulation of the air. Zoning of sections of the systems to equalize the load and the provision of similarly or equally loaded sections for the purpose of better control should be carefully considered. The institution of recirculating fans is concomitant with this arrangement. The sections or zones should further be studied for orientation. It is well established, for example, that the zone of a building with southern exposure will usually have a heavier summer load than for the north zone. The reverse usually occurs for winter service only. In other words, the heat gains for summer conditioning may be opposite to the heat losses for winter conditioning.

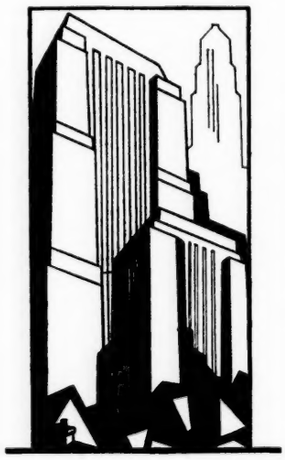
Where water is comparatively scarce or high in cost, the introduction of a cooling tower may materially offset the operating cost unless a careful study of the pumping heads is considered.

Selection of the apparatus is the fifth point. Apparatus has been quite thoroughly discussed in previous articles, and should be referred to by the reader. It is well to point out that the success of a system depends largely on a careful balance and coordination of all the component parts.

With these five items considered, the design of an air conditioning system is practically complete save for the numerous details which must be carefully watched and properly coordinated.

Air conditioning is relatively a new art. Large sums of money are being expended in research and data from actual experience being accumulated. What may be the last word in design today may become obsolete tomorrow in order that greater economy may result.

These articles that have been presented were written with unbiased opinion and for the purpose of finishing the fundamentals that go toward the design of a practical workable and economic system. Although many details have been covered in this series of articles, it has not been the intent to train the reader as a competent air conditioning engineer. Rather, the purpose has been to give the reader a clearer view of a specialized subject.



EDITORIALS

Standardized Buildings

NOW that small building construction is so sharply contracted, one of the ways much talked of for reviving it is the development of standard designs which will be greatly cheaper than those now used. Most of these plans are based on the use of factory methods whereby much of the fabrication will be done off the site. Most of the plans are now in the conversational and experimentation stage.

We have often heard of the features which these designs and methods will include but, strangely enough, we have never heard much about the heating features which will be used. If these plans develop it is fairly safe to assume, following past practice, that the heating will be shoved aside and skimped in order to permit the inclusion of other and less essential apparatus. That is the unfortunate fact, and it can be traced to our lack of a unified and aggressive organization which can push our claims to recognition.

Another point in these various schemes is that no matter how much may be accomplished in the factory fabrication of other parts, no one has yet suggested the details of a plan which will bring the heating plant to the site fully erected. There will always be work for the contractor in any of the suggestions so far made. In fact, the factory fabrication of heating plants has already been carried on to a considerable degree in recent years and it would take a revolutionary idea to carry it much farther. In this respect the heating trades are perhaps in a better position with less to fear from such designs than are many of the others whose work, as we know it now, would practically disappear if some of the proposed designs came into use.

A Good Start

AT the recent meeting of the A.S.H.V.E. a report was presented by a committee appointed to look into the application and limitations of the effective temperature index and the so-called comfort zone.

The report, appearing as "How to Use the Effective Temperature Index and Comfort Charts," is worthy of comment, not only because of itself but because it is the first time that any attempt has been made by a formally organized group from within the society to interpret these ideas for use. For the first time, too, recognition is given to the confusion which the succession of charts and zones has caused among many who have attempted to use them. The committee discussed what must have been discernible to all, namely, that the experiments as conducted resulted in case material and not in any principle or law. It was equally evident on close consideration that the index and the zones do not apply to all possible cases, or even to all cases which are commonly met with in practice. Attempts to apply the ideas to these cases was one of the factors which led to confusion. Now we have available a fairly concise statement which points out these limitations in use.

Appearance of this report also leads to another thought. Now that the way has been found, why would not the present be an excellent time to apply the same idea of interpretation to other results of the society's laboratory work? Certainly much remains to be done along these lines, for the past practice of presenting a series of fragmentary papers on a given subject has often resulted in confusion of application. Now, when many members are not pushed with work, excellent talent should be available for the consideration and consolidation of results by forming committees to do so. Not only should such action help to make many of the results of the laboratory work more useful, but a clear and concise summary statement would do much to clear the atmosphere.

Home Loan Bill

CONGRESS finally passed before adjournment the two acts from which the building industry has something substantial to gain, if they work out in practice as their sponsors hoped. The home loan bank bill has possibilities in the revival of home construction, while the relief bill authorizes funds for self-supporting public works some of which are buildings of large size. Nearly all are agreed that the inability to finance is the essential factor which is holding back much desirable and needed building. These acts are intended to help remove this difficulty. At last then we can hope for some activity as soon as the machinery created by these acts starts working. This will no doubt take some time but at least their passage justifies the expectation that some concrete activity will show itself in the building industry before long. Now is a time to take renewed courage.

Abstracts . . .

Reviews and Summaries of . . . . Current Papers, Books and Pamphlets

Principles of Refrigeration

By W. H. Motz

Cloth or morocco-bound book of 1032 pages; illustrated with many cuts and graphs and containing much tabular material; published by Nickerson and Collins, Chicago; 6 in. x 9 in.; price $7.50 cloth, $8.50 morocco.

Third edition of this book which has been adopted as a basis of a national lecture course on refrigeration for practical operating engineers. In its previous editions it has come into wide use as a text in technical schools as a 'principles' book. This edition is considerably expanded in volume, being about 40% larger than the second. Included among the subjects treated in this book are the properties and values of the principal media used in modern refrigerating apparatus; transmission of heat; functions and values of insulating materials; construction and operation of various parts of refrigeration apparatus, and application of refrigeration to many uses. The author has purposely avoided as much as possible the use of higher mathematics, and has placed the text in everyday language.

A general idea of the contents of this book may be secured from the following list of chapter headings: Introduction and Elementary Refrigeration Systems; Fundamental Units and Physical Laws; Refrigerating Media; General Principles of the Compression System; General Principles of the Absorption System; The Ammonia Compression System; The Absorption and Other Refrigeration Systems; Heat Transmission in Insulation and Apparatus; Methods of Distribution of Refrigeration; Automatic Refrigeration Systems; The Manufacture of Ice; Cooling Solids, Liquids and Gases; Cold Storage of Commodities; Cooling and Conditioning of Air; Erection and Testing of Apparatus; Operation and Care of Apparatus; Working Temperatures and Pressures; Prime Movers for Refrigerant Plant; Economics of Refrigeration; General Considerations.

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How to Use the Effective Temperature Index and Comfort Charts

Report of a committee to the A.S.H.V.E. meeting at Milwaukee, June, 1932.

The committee outlines it views of the proper way to make use of the comfort charts and effective temperature index developed by the society's laboratory over a period of years. The committee recognizes that confusion is present and states that the object is to fix desirable comfort standards for practical use.

In order to do this a rather long review of the nature of the experiments, the definitions set up, and the limitations of application of the findings is given. It seems that when the limitations of the work are taken into account, the idea of effective temperatures as defined by the committee is not nearly so universally applicable as some people had come to believe. In other words it is not a universal principle but an index which holds in certain cases. This conclusion is not so stated by the report but it logically follows from the statements made which point out that there are cases in which the idea of effective temperature does not apply. The committee analyzes the limitations of the comfort zone and finds that these limits and the whole mass of data again apply to certain cases only.

On the whole this statement is very fair and anyone who is confused by the multiplicity of "zones" and "lines" will find it good and reasonably concise.

The title is incorrect in one sense in that the report is mainly concerned with the limitations of use rather than with a positive statement of "how" to use the charts.

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Combustion

By C. George Segeler

Paper-bound book; illustrated with many figures and charts; a publication of the American Gas Association and prepared under the direction of a committee; obtainable by addressing the association at 420 Lexington Ave., New York; 208 pages; 9 in. x 12 in.; price $2.00 per copy with postage to be paid by purchaser; special price on group orders of over 30 copies.

While marked third edition, the book is stated by the author to have been completely rewritten and is really a new book.

The viewpoint is distinctly one which emphasizes the combustion of gas. Nevertheless, the author is conservative in his statements regarding gas; makes no claims that it is the all-embracing fuel. The book cannot be dismissed as merely another inspired publication of an interested group. It presents real data on combustion and its related subject of heat transfer. Much of the information is technical and analytical in character but some is entirely descriptive.

Three chapters stand out in their value to those interested in heating and ventilating because of their thoroughness, the attitude of detachedness, and the skill of the author in weighing and consolidating existing information, much of which is extremely confusing in its original form. These chapters are: Heat and its Measurement; Chemistry of Combustion, and Heat Transfer. The author has not only collected much material on those subjects; he has tabulated and classified much of it and described how it can be applied. While the book naturally has its widest appeal to gas men, still every heating and ventilating man will find in it enough of thoroughly up-to-date value to make it worth his attention.

Influence of Infra-Red Radiation in Relation to Ventilation and Heating

By Leonard Hill

Article in the Journal of State Medicine, London; December, 1931.

The feeling of stuffiness experienced by some people in a warm room has been attributed to various unknown qualities of the air. The author discounts the usually accepted reasons, and suggests that as a result of personal experiments he feels that the effects may be due to dark or dull heat rays acting on the skin, and that the longer infra-red rays are the culprits. He suggests that if the closing and congestion of the nasal passage is really due to ill ventilation, enough cool air should be sent through every room to cool the face and counteract the effects of the long infra-red rays.

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Procedure for Establishing Optimum Air Conditions for Light and Heavy Work

By G. D. Arnaoutow and E. W. Weller

Paper in the Journal of Industrial Hygiene; April, 1932.

The authors deal with the problem of finding the best conditions in that region between the comfort zone and the onset of disturbances in the heat regulating mechanism of the body. They analyze some of the existing information and conclude that there are questions left unanswered. They made use of a scale of measuring the degree of perspiration by the use of a mixture of iodine, alcohol, and castor oil placed on the forehead. They noted that in every phase of perspiration the subject experienced a corresponding sensation of warmth. They have prepared a table showing the relationship between dry bulb, humidity, and air movement necessary for best conditions.

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A Method for Determining the Most Favorable Design of Gas Burners

By John H. Eiseman, Elmer R. Weaver and Francis A. Smith

Paper appearing in the Bureau of Standards Journal of Research, June, 1932; illustrated and containing a number of curves; 40 pages.

The conditions which limit the satisfactory operation of a gas burner in its relation to the appliance are briefly discussed in a general way. Definite limits may be determined which show the conditions under which the flames flash back or blow from the ports and those under which combustion is rendered incomplete or "carbonizing" flames are produced. The relationships between these limiting conditions and several of the more important details of design and adjustment of the appliance are shown for the typical case of the top burner of a gas range burning a carbureted water gas of 570 B.t.u. The effects of the more important possible changes on the efficiency and rapidity with which heat is transferred are also shown, and the most favorable combination of conditions is systematically developed. The effects of the allowances which must be made in design for anticipated variations of pressure and inaccuracy of adjustment are also shown.

An appendix describes the laboratory apparatus which has been developed for experimental work of the kind involved.

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Investigation of Air Outlets in Classroom Ventilation

By G. L. Larson, D. W. Nelson and R. W. Kubasta

Paper presented at the Milwaukee meeting of the A.S.H.V.E., June, 1932; illustrated and with 13 graphs showing results; study made at the University of Wisconsin; approximately 8000 words.

The authors measured the air flowing out of the planned outlets in certain classrooms of several school buildings. They also studied the air distribution in those rooms, both when the planned outlets were open and when closed. In some cases studies were made with unit ventilators operating, some with central fans operating, and some when both were operating. The authors also studied the air quantities when window ventilation was used. Their studies thus covered a considerable range of room types and ventilation methods. The study was undertaken to learn of the influence of outlet vents on schoolroom ventilation.

Much of the paper is taken up with a discussion and description of the calibration of instruments which appears to have been given a great deal of attention. The data collected were considerable in amount and a large part of the paper is taken up with its presentation and discussion. Curves show the relations found but the principal findings were that the amount of air leaving through the planned openings was not the same as the amount supplied and that this percentage varies with the building. Sealing of the planned outlets resulted in reducing the amount of air delivered to the rooms from 3% to 25%. When open window ventilation was used, an air inflow was found on both the windward and leeward sides. After correction for room location relative to building height about 40 f.p.m. resulted from each mile of wind velocity when the outlets were open and 27 f.p.m. when outlets were closed.

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Natural Wind Velocity Gradients Near a Wall

By J. L. Blackshaw and F. C. Houghten

Paper presented at the Milwaukee meeting of the A.S.H.V.E., June, 1932; illustrated; contains 1 table and 7 graphs with results of the tests plotted; approximately 3000 words.

The authors undertook a study to learn if the results obtained by moving a large surface through still air were comparable with those obtained by a similar stationary surface in moving air. They found that they were. Having shown this they also developed a formula from their data whereby the velocity of flow at any distance from the surface may be found if one knows the velocity of free air. It is doubtful if the values as found would apply to all building walls as a smooth-surfaced wall was used during the tests.

News of the Month

Abnormally Mild Winter in 1931-32 Decreases Fuel Consumption

Decreases as much as 34.8% in the number of degree days as compared with "normal" were recorded in the winter of 1931-32. The greatest drop as compared with normal was recorded in New Orleans, which also showed the greatest decline as compared with the previous heating season.

Inasmuch as fuel consumption varies with the number of degree days, the decline in fuel consumption for the heating of buildings, as compared with the previous year, amounted to 12.9% in New York, 11.2% in Chicago, 18.9% in St. Louis, 16.3% in Pittsburgh, 20% in Baltimore, 17.2% in Philadelphia, 14.9% in Detroit, and 16.7% in Indianapolis.

As compared with the normal, computed from weather records over a fifty-year period, the drop amounted to 16.9% for New York and Chicago, 21.8% for St. Louis, 22.7% for Philadelphia, 18.4% for Cleveland, and 13.3% for Cincinnati.

Of the twenty-five cities for which records are computed by HEATING AND VENTILATING, all but one showed decreases from normal. The exception was Los Angeles, which registered an increase of 0.7%. Twenty-one of the cities showed decreases as compared with the season of 1930-31, the exceptions being Seattle, San Francisco, Minneapolis and Los Angeles.

Detailed figures are shown in the accompanying table.

City	Deg. Days for 1931-32	Per Cent Change Over Normal Year	Per Cent Change Over Season 1930-31
New York	4443	— 16.9	— 12.9
Seattle	4902	— 1.3	+ 11.9
San Francisco.	3071	— 5.9	+ 50.5
Chicago	5251	— 16.9	— 11.2
Denver	5648	— 3.8	— 1.1
Boston	5159	— 14.7	— 6.6
St. Louis	3581	— 21.8	— 18.9
Pittsburgh ...	4588	— 12.3	— 16.3
Minneapolis ..	6944	— 11.5	+ 2.1
Los Angeles ..	1514	+ 0.7	+ 127.8
Baltimore	3484	— 23.2	— 20.0
Philadelphia ..	3752	— 22.7	— 17.2
New Orleans..	656	— 34.8	— 54.2
Atlanta	2165	— 25.1	— 36.9
Cleveland	5021	— 18.4	— 13.9
Cincinnati	4076	— 13.3	— 19.6
Detroit	5428	— 16.4	— 14.9
Buffalo	5963	— 12.6	— 9.0
Birmingham ..	1776	— 26.3	— 39.2
Indianapolis ..	4459	— 15.9	— 16.7
Memphis	2223	— 24.6	— 32.0
Des Moines ...	5595	— 12.2	— 1.4
Kansas City ..	4168	— 19.9	— 8.7
Louisville	3521	— 15.8	— 23.4
Galveston	845	— 16.8	— 39.8

Condemns Government Encroachment on Private Engineering Practice

In a letter to Representative Joseph B. Shannon of Missouri, chairman of the House subcommittee investigating Government competition with business, E. J. Russell, of St. Louis, president of the American Institute of Architects, charges that Federal bureaus are encroaching upon the practice of private architects and engineers. During the recent session of Congress, it is pointed out, Representative Robert A. Green of Florida introduced a bill intended to eliminate some of the governmental competition with private business in so far as the office of the Supervising Architect is concerned. The bill failed to be reported out favorably by the committee.

Federal bureaus in Washington maintaining separate divisions or sections whose function it is to prepare plans and specifications for new buildings erected within their respective jurisdictions include the office of the Supervising Architect of the Treasury Department, the Veterans' Bureau, the Bureau of Yards and Docks of the Navy Department, and the office of the Quartermaster of the War Department. According to Mr. Russell, the private architect or engineer has no chance of appointment in connection with any Federal building unless the particular bureau concerned desires to give him a chance, a circumstance only arising when the pressure of a large volume of work or the complexity of a given building problem makes the employment of some outstanding architect or engineer unavoidable.

E. E. Dubry, elected president of the National District Heating Association at its annual meeting in June

Mr. Russell asserts that the American Institute of Architects does not concur with the statement of representatives of the office of the Supervising Architect that the Treasury Department can perform architectural services at a cost less than the private architect, except with respect to the smaller buildings. The institute opposes any public works legislation which by civil service limitations deprives the Government of the possibility of engaging the services of the country's ablest technical men engaged in private business. It also condemns a system which imposes upon the country at large, regardless of local conditions and local materials, standardized types of public buildings, which is not in reality an economy measure.

Federal Building Construction at $27 Million Last Year

A total of $26,952,557 was disbursed by the Government for the building of 90 post offices, marine hospitals, customs buildings, and other structures during the fiscal year that ended June 30, according to the Treasury Department. Approximately 75% of the public building program specifically authorized at the time the fiscal year closed was either completed or under contract.

It is indicated that the building activity of the Government will decline after reaching a peak this fall since there were only 106 projects, amounting to $31,342,400, in the drawing stage on June 1, 1932, as compared with 193 projects costing $188,403,023 on the same date a year previous. Specific authorizations for buildings were increased by only about $1 million during the fiscal year, and the Treasury Department will not volunteer new recommendations for authorizations before June, 1933, at the earliest, it is said.

Potter Nominated for President of A. S. M. E.

For president of the American Society of Mechanical Engineers for 1933, the nominating committee of that body has designated A. A. Potter, Dean of Engineering, Purdue University. Dean Potter was born in Russia, in which country he received his early education. Shortly upon coming to the United States he entered Massachusetts Institute of Technology, from which he was graduated in 1903 with the degree of B.S.

After completing his training, Dean Potter entered the employ of General Electric Company and was associated with the early development of the steam turbine. In 1905 he became assistant professor of engineering at Kansas State College and in 1920 became connected with Purdue University.

The committee nominated for vice-presidents C. F. Hirshfeld, chief of research department, Detroit Edison Company; Harold V. Coes, manager of the industrial department of Ford, Bacon & Davis, Inc., New York; and James D. Cunningham, president of the Republic Flow Meters Co., Chicago. Alex D. Bailey, superintendent of generating stations, Commonwealth Edison Co., Chicago; John A. Hunter, professor of mechanical engineering at the University of Colorado, and R. L. Sackett, dean of the School of Engineering, Pennsylvania State College, have been nominated as managers of the society.

President's Conference Offers Plan to Improve Home Building

In a report issued July 6, the President's Conference on Home Building and Home Ownership places responsibility for the poor quality and high cost of residential building on a lack of organization in the building industry. The report contains detailed plans for correcting the situation by instituting a greater measure of cooperation among the various elements of the building industry.

It is pointed out in the report that the development of heating, plumbing, lighting, and refrigerating equipment is far in advance of other phases of housing. A great deal of data on this fundamental equipment is included in the report, and the authors of this section have endeavored to make this vast body of facts available to the builders of low-cost houses and small homeowners who have hitherto benefited but little from it. Standards of fundamental equipment are fixed in the volume, and advice as to the means of securing equipment to meet these standards is included. The costs of different types of heating and air conditioning equipment and similar household apparatus are compared, and their advantages and disadvantages weighed. Principles of operation are expounded, and the merits of different kinds of fuels discussed, providing a practical reference work to guide the builder, owner, or renter of a house in the most efficient operation.

60,000 Attend Exposition Held by Master Plumbers at Annual Convention

Madison Square Garden, New York, was the scene of the Golden Anniversary Exposition and Convention of the National Association of Master Plumbers, June 20-23. Delegates officially representing local associations from all over the country numbered 435, and a total registration of 3350 delegates, members, and guests was recorded for the meeting and convention features held on the three days commencing June 21. It was estimated that 60,000 persons visited the exposition held in connection with the convention.

William J. Flynn, vice-chairman of the convention and exposition committee, opened the Tuesday morning session with a brief message of greeting, following which he introduced Patrick W. Donoghue, president of the association. Mr. Donoghue delivered a short address of welcome, and expressed gratification over the large attendance.

Mr. Flynn next introduced Dr. Shirley W. Wynne, Commissioner of Health for the City of New York, who outlined the progress in health and improved living conditions made in that city during the past half century, due largely to sanitation.

Grover A. Whalen, president of the Advertising Club of New York, followed with an address "Advertising and Business." Mr. Whalen attributed the present economic maladjustment to carelessness and extravagance, which have brought about a collapse of confidence and arrested credit expansion. He named business leadership as the greatest need of the present.

Tuesday afternoon was devoted to the presentation of a series of dramatic sketches interspersed throughout an address "The Master Plumber and His Association," by C. W. Wagner, chairman of the sales promotion committee. This

program depicted the foundation and subsequent history of the association.

Dr. Julius Klein, Assistant Secretary of the United States Department of Commerce, opened the Wednesday morning meeting with an address "Business of Today." Doctor Klein warned that care must be used in expansion at the present time, saying that the country cannot be committed to an extension of credit now. According to the speaker, the country will probably not progress at the same pace as it has in the past. Since the rate of population increase is diminishing, the market for new building will be restricted. New ways of doing old things must be found.

Doctor Klein also stressed the importance of manufacturers' analyses of markets, and described the terrific wastes that have resulted from lack of information on distribution. Costs must be known, and scrupulously applied cost accounting must regulate selling campaigns. It was the speaker's opinion that the smaller manufacturers have less cause for concern in the present difficulty than the larger organizations.

Following a report of the standardization committee by Jere L. Murphy, chairman, Oscar H. Fogg, vice-president, Consolidated Gas Co., New York, delivered an address on "Trade Relations."

Edward B. Kleine, newly-elected president of the National Association of Master Plumbers

On Wednesday afternoon, Joseph G. Hildebrand, secretary-manager, Plumbing and Heating Industries Bureau, reported on the Cincinnati Survey, sponsored by the association for the purpose of studying the effectiveness of direct-to-you merchandising in competition with manufacturer-to-wholesaler-to-contractor-to-consumer distributing of heating and plumbing appliances. The Cincinnati area was selected for the survey because of the unusually large amount of competition to be found in that territory. It was found that 68.8% of plumbing and heating materials sold in an area of 50 square miles including and surrounding the city of Cincinnati was bought through contractors who purchased it direct from wholesalers, and 27.3% was the total direct-to-you volume of sales to the public. Cooperate purchases by contractors amounted to 3.9%. Commenting on this survey in his annual report, President Donoghue said that it proved conclusively the soundness of the method of distribution practiced in the plumbing and heating industry, and despite the inroads made in the field by direct-to-you organizations, they are not prospering.

An open forum discussion on the subject "The Three Forces of Selling," conducted by Russell G. Creviston, sales promotion manager, Crane Co., Chicago, concluded the Wednesday afternoon meeting.

The following officers for the ensuing year were elected at the final session of the convention: Edward B. Kleine, Cincinnati, president; Robert J. Barrett, Washington, D. C., vice-president; H. O. Green, Tulsa, Okla., treasurer; Edward Frank, Cincinnati, secretary.

New "S. S. Manhattan" Has Elaborate Ventilating System

The *S. S. Manhattan,* the largest American-built liner, which arrived in New York on July 26 from her sea trials and which will depart on her maiden voyage August 10, is elaborately heated and ventilated. The vessel is the first liner to be built in an American shipyard for the North Atlantic trade in 35 years. It is owned by the United States Lines.

The vessel's length of 705 ft. overall and her 24,000 tons gross register make her the largest liner ever built in this country. Her beam measurement is 86 ft. and moulded depth 47 ft. She has a guaranteed service speed of 20 knots. She is designed to carry 1250 passengers in cabin class, tourist and third class. Her capacity for general cargo is 380,000 cu. ft. and she can carry 47,000 cu. ft. of refrigerated cargo.

The *Manhattan,* due to its size, could only be effectively ventilated by mechanical systems. Including the boiler and engine spaces, 87 electrically-driven fans provide for the delivery and exhausting of air. The fans are mounted on special foundations and operated at low speed to ensure silent operation. All fans below the weather decks are located in fan rooms with steel bulkheads, made sound proof by lining with felt insulation.

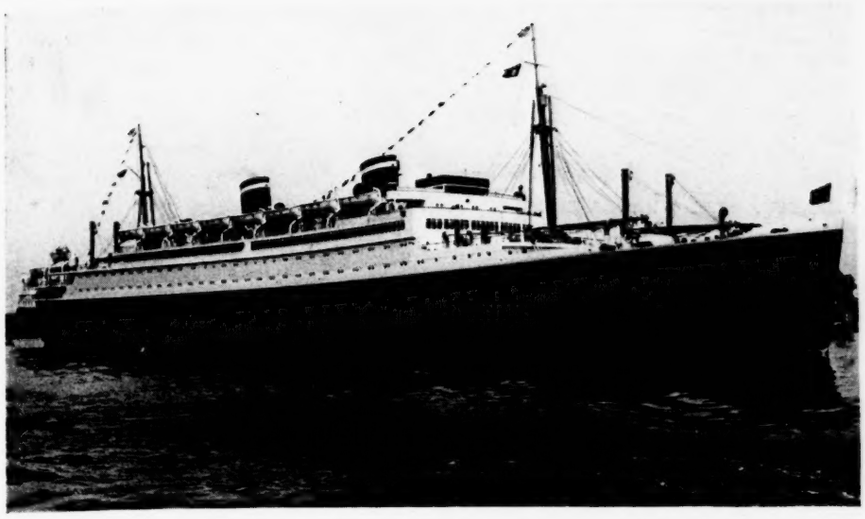
The cabin and tourist dining saloons are provided with conditioned air. There are two conditioner units serving each room, each unit consisting of a preheater, washer, cooling and heating coils capable of heating or cooling the air as required. The air enters the rooms through ceiling grilles at a low velocity.

The ventilation systems to all parts of the vessels were designed in collaboration with the Thermotank Limited of Glasgow. Air is distributed to all cabin, tourist and third class accommodations through punkah louvers. The louvers being adjustable, the air can be directed to any spot in the staterooms. The air can be heated to maintain a temperature of 70° when necessary by fin tube heaters attached to the fans.

The natatorium and swimming pool is equipped with both supply and exhaust systems. The supply system is arranged with heaters that give a temperature in these spaces 10° higher than in the living spaces.

The galleys have independent supply and exhaust systems. The main galley being located between the cabin and tourist dining saloons, the exhaust system has been designed with a 100% greater capacity than the supply system, thereby drawing air from the two dining rooms.

Exhaust systems are provided



The new "S. S. Manhattan," with air conditioned dining saloons and capable of carrying 47,000 cu. ft. of refrigerated cargo, returning from her trial trips July 26

from all public and private baths, showers and toilets. Each public room has its supply system and they are heated by steam radiators concealed behind metallic ornamental grilles. All ducts in cabin and tourist accommodations are concealed behind ceilings, the louvers only being visible. All systems equipped with heating facilities are insulated with asbestos cell board.

With all vent systems on the vessel operating at one time the fans exclusive of the boiler rooms (which have a forced draft blower system) handle a total volume of 458,000 c.f.m. distributed as follows:

Staterooms and public spaces—210,900 cu. ft. supply, change of air complete every 5 min.

Public and private baths, toilets, showers, 46,400 cu. ft. exhaust, change of air complete every 4 min.

Galleys—20,500 cu. ft. supply—41,800 cu. ft. exhaust, change of air complete every 2 min.

Cabin dining saloon—18,000 cu. ft. supply—change of air complete every 4½ min.

Tourist dining saloon—9,500 cu. ft. supply—change of air complete every 4½ min.

Third class dining saloon—4,000 cu. ft. supply—change of air complete every 4½ min.

Provision for the heating of cabin state rooms has been made by fitting brass finished, cabinet enclosed extended surface radiators. These radiators may be considered as booster elements and are heated by hot water supplied from the ship's hot fresh water circulating system.

A two-pipe steam heating system at 45 lb. pressure is fitted for heating with separate radiators in all public rooms, public toilet, and officers' and engineers' quarters on the boat deck. Steam is supplied by the high pressure evaporator and the returns are led back through multiport drainers to the high pressure evaporator drain tank. The steam heating system is arranged in sections, each of which may be eliminated from the various circuits without interfering with the heating of other parts of the vessel.

The radiators fitted in the public rooms are of the lightweight type mentioned above, concealed behind metallic ornamental grilles. Radiators in public toilets and officers' and engineers' quarters are of the cast iron wall type. Brass coil radiators are fitted in the pilot house and chart house.

Twenty-five thousand four hundred feet of extra heavy toncan iron pipe and 900 ft. of polished white metal pipe was used in installing the heating system.

A. S. H. V. E., at Convention, Votes to Submit Ventilation Standards to Members

A total registration of 335 members was recorded at the semi-annual meeting of the American Society of Heating and Ventilating Engineers, which convened at the Hotel Pfister, Milwaukee, Wis., June 27-29. Technical sessions were held on each of the three days, and a number of valuable papers were presented.

A message of greeting delivered by E. A. Jones, president of the Wisconsin chapter, opened the first session on Monday morning. An address of response by President F. B. Rowley followed, and after the report of the council had been rendered, J. M. Dallavalle presented a paper entitled "Velocity Characteristics of Hoods Under Suction."

In his discourse, Mr. Dallavalle propounded the theorem: "The positions of the velocity contours for any hood when the contours are expressed in terms of the velocity at the hood opening are purely functions of the shape of the hood; the contours are identical for similar hood shapes when such hoods are reduced to the same basis of comparison." To illustrate, if the velocity 4 in. outward along the axis of an 8-in. round duct end is 26% of the velocity in the plane of the opening, the same value must occur for a 12-in. diameter duct end at a distance of 6 in. The speaker carried over his work to include rectangular duct openings as well as round openings, and the effect of the degree of flare at the hood opening was determined. Velocities within the sphere of influence at the duct opening were graphically represented on charts.

J. L. Blackshaw, research engineer at the society's Pittsburgh laboratory, next presented a paper on "Natural Wind Velocity Gradients Near a Wall," which he had prepared in collaboration with F. C. Houghten, director of the laboratory. In this paper a report is made on investigations carried out for the purpose of checking the accuracy of data obtained in an earlier study of wind velocity gradients near a wall, made by placing the wall on a moving truck. In the new experiments, the wall was erected on the

observation platform atop the tower of the new Cathedral of Learning, University of Pittsburgh, and in this way all effects foreign to the natural conditions encountered in air flow parallel to a surface were eliminated. Curves plotted to show the relationship between the velocities in free space and the velocities at given distances from the wall surface showed practically no deviation from the previously determined data with the exception of those for the higher velocities. A formula expressing the relationship between free wind velocity and the velocity at any distance from the surface was given, and also a chart from which the relationships may be read.

A report of the committee on revision of constitution and by-laws, by W. T. Jones, chairman, concluded the business of the first session.

Tuesday morning meeting opened with a review by F. C. Houghten of the paper on "How to Use the Effective Temperature Index and Comfort Charts," by C. P. Yaglou, chairman of the technical advisory committee on re-study of comfort chart and comfort line. In the paper, the author states that effective temperature is an index of warmth or cold, and is not of itself an index of relative comfort. Effective temperature is defined briefly as an arbitrary index of the degree of warmth or cold felt by the human body in response to various temperature, humidity, and air movement conditions.

The purpose of this report was to clarify certain obscure points pertaining to the effective temperature indexes, and to fix, in the light of present knowledge, desirable comfort standards for practical use. In some publications the comfort line for the winter season is placed at 64° effective temperature, while in others it is given as 66° effective temperature. This circumstance resulted from the fact that two different scales of effective temperature have been developed in the research laboratory—the basic and the normal. One of these is applicable to individuals working at hot occupations, for which they are generally stripped to the waist, and the other is used for ordinary ventilation work, where the individuals are normally clothed. The average winter comfort zone has been fixed between the limits of 63° and 71° normal effective temperature, and the comfort line at 66° normal effective temperature.

It has also been found, it was reported, that while a number of individuals vary as to their reactions to humidity conditions, it is desirable to restrict the comfort zone to the range of relative humidity employed in the comfort zone experiments, namely, between 30% and 70%, until more exact information is available. From the standpoint of health, however, the consensus of opinion favors relative humidity between the limits of 40% and 60%. It is noted that the artificial humidification should be reduced to less than 40% in subfreezing weather, unless effective precautions are taken to insulate exposed surfaces to prevent damage from frozen condensate.

In the conclusion of the report, it is stated that the average winter comfort line (66° effective temperature) applies to average American men and women living inside the broad geographic belt of the United States in which central heating of the convection type is generally used during four to eight months of the year. It does not apply to spaces heated by radiant energy, and is not advocated for use in foreign countries where climate, heating methods, and general living conditions are materially different from those in this country. It is also suggested that the comfort chart is not applicable in the warm south and southwestern climates and in the cold north central climate of the United States. Somewhat lower temperatures are recommended for densely occupied spaces, such as classrooms, theaters, auditoriums, and the like, than those indicated on the chart, since there will be counter radiation between the bodies of the occupants in close proximity. In rooms in which the average wall surface temperature is considerably below the air temperature, higher air temperatures are necessary. The reverse holds true where radiant or panel heating is in use. The use of the summer comfort line (71° effective temperature) is applicable to the same geographic area as the winter comfort line, and is restricted to cases in which the human body has reached equilibrium with its environment. This takes place after 1½ hr. to 3 hr. exposure.

A question was raised by H. W. Schmidt, of the Wisconsin State Board of Education, as to the possibility of altering the chart to adapt it for use in figuring comfort for children from 10 yr. to 15 yr. of age. He stated that the board has determined that the reactions of a child between the ages mentioned differ from those of an adult, and that a higher temperature is required. Mr. Houghten replied that sufficient data had not been gathered to date to permit the answering of Mr. Schmidt's question.

E. K. Campbell, Kansas City, Mo., next presented a brief discussion on the investigations that are being carried on in garage ventilation. Two papers, "Carbon Monoxide Distribution in Relation to the Ventilation of a One-Floor Garage," and "Carbon Monoxide Distribution in Relation to the Ventilation of a Ramp Garage," both by F. C. Houghten, and Paul McDermott, were reviewed by Mr. Houghten, who illustrated his discourse with lantern slides.

The first of these papers was a record of a study made in the Sheraden Garage, Sheraden, Pa., as authorized by the Research Laboratory. It was concluded that the visible smoke rose quickly after leaving the car due to its higher temperature, and that the higher carbon monoxide concentration is found near the ceiling. This would indicate that the vitiated air should be removed at the top of the garage, and the incoming air should be introduced at the floor.

In these experiments, the incoming air was supplied at a temperature slightly lower than that prevailing in the garage, which further aided in the stratification of the exhaust gases at the ceiling. If the incoming air is supplied at a temperature higher than that prevailing in the garage, convection currents may be set up which will distribute the carbon monoxide throughout the space. The more economical system will remove the carbon monoxide from the point where it tends to collect soon after leaving the car. It is stated that for a condition of equilibrium between carbon monoxide production and air supply in a garage the rate at which carbon

monoxide is being produced and added to the air is equal to the volume of air supplied (or exhausted) multiplied by the per cent of carbon monoxide in the garage air at the point of exhaust. This calculation can be applied to the condition for cross ventilation and upward ventilation. A table included in the report gives the volume of air per minute required to dilute the exhaust gases of vehicles of different types and degrees of operation to a concentration of one part of carbon monoxide in 10,000 parts of air.

The second of these garage ventilation papers reported the studies conducted in the underground ramp garage of the Grant Building, Pittsburgh, Pa. These surveys showed that with normal car operation the ventilation capacity provided by the fans is ample or excessive, and that the amount of air supplied probably could be reduced. This reduction could be made with safety if some instrument for indicating the concentration of carbon monoxide was available.

A higher average of carbon monoxide concentration near the ceiling was quite consistently noted in this survey. This does not noticeably hold true, however, for conditions where a large number of cars are driven through the roadways of the different floors, resulting in a mixing effect. The surveys further indicated that comparatively little advantage can be gained by upward ventilation on the different floors of a ramp garage because of the fact that all of the different floor spaces are interconnected, and because of this mixing action of the cars passing from one floor to another. A table is included giving the vertical distribution of supply and exhaust air.

In the discussion which followed, E. K. Campbell expressed the opinion that human comfort in garage ventilation was the problem, and that it automatically took care of the safety factors in connection with carbon monoxide concentration.

D. W. Nelson next reviewed a paper on "Investigation of Air Outlets in Classroom Ventilation," which he had prepared in collaboration with G. L. Larson, and R. W. Kubasta. Lantern slides were used in presenting charts. In the discussion, John Howatt, Chicago, stated that investigations in Chicago had indicated that satisfactory results are to be obtained when smaller outlets are used.

The final business of this session was the report of the committee on ventilation standards, which was presented by Prof. A. C. Willard, in the absence of W. H. Driscoll, chairman. Professor Willard read a letter from Mr. Driscoll in which the report was summarized. In the letter, it was pointed out that the proposed standards are strictly for the society and in no way to be considered an endeavor to frame standards for state or municipal legislation. The difference in opinion existing between the medical and engineering professions in regard to ventilation was also referred to, with the comment that the medical profession has not presented a solution to the problem. It was moved and carried by oral vote that a letter ballot on the proposed ventilation standards be sent to the membership of the society.

On Wednesday morning the final technical session was held. This meeting commenced with the reading of a paper on "Thermal Properties of Building Materials," by F. B. Rowley and A. B. Algren. Two tables are included in the paper, the first giving the coefficients of heat transmission and surface constants for various types of wall construction, and the second showing the variations in conductivity in concrete as affected by age.

Three written discussions were read on this paper. In the first, Paul D. Close called attention to the fact that these tests give higher insulating values to most of the materials than are ascribed to them in the "Guide." J. S. Bush, in his discussion on this paper stated that he had found actual wall tests to give more dependable results than the hot box method. In a third discussion, by R. E. Backstrom, attention was called to the fact that there are several kinds of pine, and that there is a pronounced variation in heat coefficients between them. It was also noted that the coefficients of heat transmission in brick walls vary due to the different clays used.

M. K. Fahenstock next presented a paper on "Tests of Convection Heaters in a Warm Wall Testing Booth," which he had prepared in collaboration with A. P. Kratz and E. L. Broderick. The paper contains an outline of the test methods, in which cast iron radiators and convectors were tested in a warm wall booth and in a low temperature room where actual conditions were simulated. Performance curves for the various convectors are included, and also a chart to show the deviation of the calculated correction from the test curve obtained under actual working conditions.

R. M. Conner, director, American Gas Association Testing Laboratory, spoke briefly at this time on the tests made by the A.G.A. on gas-steam radiators. Professor Willard spoke in approval of tests made under actual service conditions.

"Automatic Gas Burners," a paper by C. George Segeler, industrial engineer, A.G.A., concluded the technical business of the convention.

The meeting concluded with the report of the chapter relations committee, which was given by E. K. Campbell. It was stated that reduced income to the society's treasury has necessitated a corresponding curtailment of activities. Final action is scheduled for January on an amendment to the by-laws, permitting the assessment of dues to be taken out of the by-laws for 1933 and 1934, in order that this assessment may be lowered to meet the present situation.

Attractive entertainment features were arranged for the women, and while not busy in meetings the men enjoyed golf and inspection trips to industrial plants. An entertainment and dance occupied the members and their guests on Monday evening, and on Tuesday evening the semi-annual banquet and dance was held in the Fern Room of the Hotel Pfister.

News of the Month

T. W. Reynolds and *F. D. Halama* have opened offices as engineers and contractors in heating, ventilating, and air conditioning. They have incorporated under the name of Reynolds & Halama, Inc., with offices at 25 East 26th St., New York.

News of the Month

Bulletin Treats on Hand-Fired Plants

Educational Bulletin No. 4, devoted to the subject of "Solid Fuels and Their Use in Hand-Fired Plants," has been issued by the Committee of Ten, Coal and Heating Industries. Six chapters are included, covering heating plants and their care, instructions for hand-firing domestic heating plants, trouble shooting, hand-firing large low-pressure plants, terms and definitions, and classification of solid fuels. The bulletin is authoritatively written, and is said to form probably the best reference now available for the coal merchant and coal salesman handling this class of business.

Hanburger Offers Correspondence Course

Prof. Fred W. Hanburger, of the faculty of the College of the City of New York, who has conducted the Your Everyday Problems department in HEATING AND VENTILATING for some time, has announced that he will personally offer a correspondence course covering hot water heating, steam heating, warm air heating, and ventilating and air conditioning.

Professor Hanburger has contributed on numerous occasions to HEATING AND VENTILATING, a series of 15 parts covering the design of steam and water heating systems having been concluded in the March, 1931, issue. The popularity of this series and of his department now appearing are partially responsible for the decision to offer the course.

Particulars regarding the course can be obtained by writing Prof. Fred W. Hanburger, 439 W. 38 St., New York, N. Y.

Committee of Ten Studies Coal Consumers' Attitude

A study of the problem of furthering consumer satisfaction in the utilization of solid fuels was made by about 100 representatives of the coal producing and distributing and related equipment industries at the annual meeting of the Committee of Ten, Coal and Heating Industries, held in Chicago, June 20.

In his annual report, Chairman H. A. Glover reviewed briefly the purpose of the group, and described the progress that has been achieved. This work has been directed along two major lines of endeavor which embrace the establishment of closer contacts between the members of the coal and related equipment industries in the various localities, and the dissemination of authoritative and constructive information concerning the marketing and utilization of the products and equipment marketed by the industry through the Information Bulletin Series and the Educational Bulletin Series.

Homer Addams on Power Show Committee

Homer Addams, president of Kewanee Boiler Co., Inc., New York, and past president of the A.S.H.V.E., has been appointed a member of the exposition advisory committee of the Tenth National Exposition of Power and Mechanical Engineering, which will be held at the Grand Central Palace, New York, December 5-10.

Congress Approves Home Loan Bank Bill

Just prior to adjournment on July 16 both Houses of Congress passed the Federal Loan Bank bill (H. R. 12280) with the national bank currency expansion program attached. This legislation creates a new and independent system of banks, with a capital of $125 million, to render financial aid to home owners through rediscount of home loan mortgages held by various types of corporations. The system will include a minimum of eight and a maximum of twelve Federal Home Loan Banks with a Federal Home Loan Bank Board of three members in Washington to supervise the bank activities after the manner in which the Federal Reserve Board operates.

President Hoover signed the bill on July 22, after it had been placed in the hands of the Comptroller of Currency for approval. The Treasury Department advised that the provision for the limited extension of national bank currency will not result in inflation.

It is provided that the Treasury will acquire the entire capital stock at the outset, and that borrowing institutions may qualify for that privilege only by becoming members of the bank in their jurisdiction, such qualification requiring that they subscribe to stipulated amounts of the capital stock. The currency expansion program which was added to the bill by the Senate, and ultimately accepted by the House of Representatives, will expand the note circulation of national banks by $995 million.

Oil Burner Markets Graded by Association

An exhaustive analysis, in which the potential market for domestic oil burners is indicated for each county in the United States, has recently been completed by the American Oil Burner Association. The survey, entitled "Graded Oil Burner Markets," has been prepared specifically for executives charged with the responsibility of sales, advertising, or market expansion, and provides state and county index bases on which localized market maps may be accurately prepared.

Founded on concentration of market, standard of living, and possession of wealth, the base index takes into account such factors as: number of dwellings, number of families, number of families having telephones, number of urban and rural electric service users, number of income tax returns filed, and spendable money index. The ratio between the county and national indices in the foregoing respects provides the base index, and with it

COMING EVENTS

OCTOBER 10-14, 1932. Fourteenth Annual Convention of the American Gas Association, to be held in Atlantic City, N. J.

OCTOBER 24-27, 1932. Sixty-First Annual Conference of the American Public Health Association, to be held in Washington, D. C.

NOVEMBER 30-DECEMBER 4, 1932. Annual Meeting of the American Society of Mechanical Engineers, to be held in the Engineering Societies Building, New York.

DECEMBER 5-10, 1932. Tenth National Exposition of Power and Mechanical Engineering, to be held at the Grand Central Palace, New York.

DECEMBER 7-10, 1932. Twenty-Eighth Annual Meeting of the American Society of Refrigerating Engineers, to be held in New York.

are correlated factors peculiar to, or related to, the sale of oil burners, such as climate and the competitive fuels available in the region.

Determination of markets is separated into three classifications including values per 1000 square miles, by groups of states, values per 1000 square miles by individual states, and market values by counties. In this manner effort is concentrated in definite geographical units permitting economical development of markets in states that are individually weak but adjacent to more productive territory, and avoiding confusion which may result from making direct comparisons between the index values of counties located in widely separated states with varying market conditions.

Correspondence

Cooling Below the Wet Bulb Temperature

EDITOR, HEATING AND VENTILATING:

It is a known fact that if men hear a statement repeated over and over again for a long enough period of time, they learn to believe it without ever questioning its truth. Consequently, it is not surprising that most heating, ventilating and air conditioning engineers believe implicity in the following three statements:

1. That water cannot be cooled by evaporation to a temperature lower than the outside wet bulb temperature.
2. That the wet bulb temperature of an air stream cannot be lowered by the evaporation of moisture alone.
3. That the total heat of an air stream cannot be reduced without the use of some external source of energy such as mechanical refrigeration or cold water.

I wish to state emphatically that all three of these statements are absolutely untrue.

By regenerative cooling, as described in the May, 1932 issue of HEATING AND VENTILATING, I have cooled water 0.5° to 1° below the outside wet bulb temperature, reduced the wet bulb temperature of air 8.5°, and its total heat 6.3 B.t.u. per lb. solely by the evaporation of moisture.

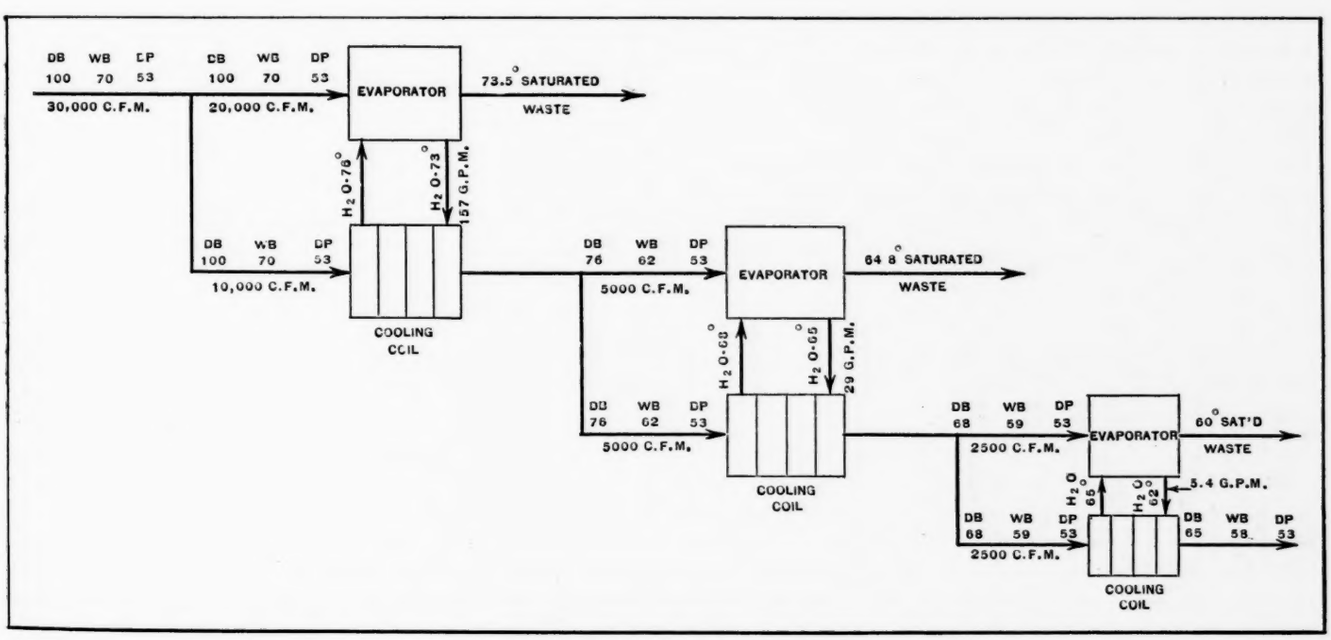
In view of these experimental facts I must, therefore, state that O. O. Sunderland's figures in the July, 1932 issue of HEATING AND VENTILATING, which prove that this cannot be done, are greatly in error. In the article referred to above, I stated that air had actually been cooled to within 4° of the outside wet bulb temperature. Mr. Sunderland states that the same results could be obtained by adiabatic cooling. This is not true, however, because adiabatic cooling does not reduce the total heat of the air treated, whereas in the experiment referred to, the total heat was reduced 6.3 B.t.u. per lb. Mr. Sunderland lost sight of the fact that the regenerative method cools air without adding any moisture to it, which is not the case with adiabatic cooling.

The sketch below represents a more simplified form of multi-stage regenerative cooling which shows how air can be cooled below the outside wet bulb temperature by evaporation. The figures are based upon the use of evaporators which will cool water to within 3° of the entering wet bulb temperature and cooling coils which will cool air to within 3° of the entering water temperature, both of which conditions can easily be attained in actual practice.

The figures show a perfect heat balance with air leaving the last stage 5° below the outside wet bulb temperature. No use has been made of the cool exhaust air from the three evaporators. If this air is used in interchangers, and if sufficient surface is used in the evaporators and the cooling coils, the limit to which air can be cooled by this method is not the wet bulb temperature, but the dew point temperature.

K. P. BRACE

New York, N. Y.



Multi-stage regenerative cooling

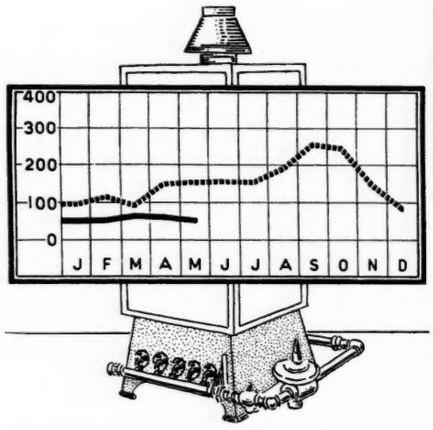
Business Statistics

(Dotted line in charts, 1931; solid line, 1932)

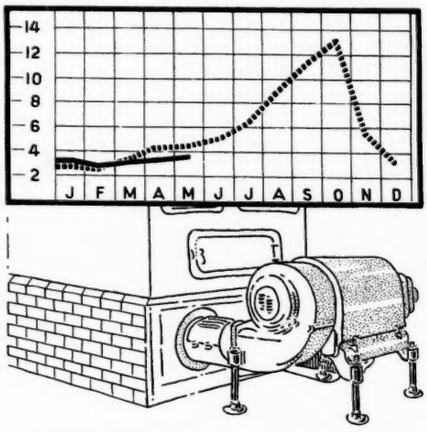
That distribution of products in this industry is still largely through jobbers is shown by the U. S. Census of Distribution Reports. Approximately 30½% of steam fittings and hot water heating apparatus is sold through wholesalers and jobbers, 40.7% through the manufacturers' branches, 18.6% to large consumers, such as factories, and 10.2% to retailers and dealers. Wholesalers sell 21.5% of the boilers, branches of the makers sell 51.6%, 14% goes through large consumers and 12.9% to dealers. Radiators are divided among wholesalers and manufacturers' branches, the former selling 29.7% and the branches 70.3%. Of valves and fittings, 83% are sold to jobbers, 16% to large consumers, and 1% to retailers.

Wholesalers distribute 42.6% of the warm-air furnaces, dealers account for 31.7%, all types of consumers buy 23.5%, and branches dispose of only 2.2%.

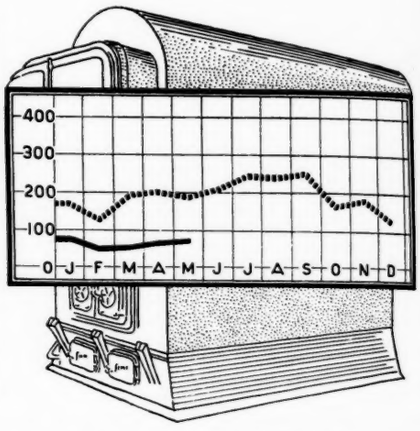
Large and small consumers buy 15.6% of the domestic oil burners direct from the maker, wholesalers taking 32.8% of the output. Dealers account for 33.3%, and branch distributors sell 18.3%.



Shipments of Gas-Fired Boilers
In Thousands of B.t.u. Capacity
May, 1932, 57,723; May, 1931, 154,650.
Decrease from last year, 62.6%.



Domestic and Commercial Oil Burners
Shipments in Number of Units
May, 1932, 3759; May, 1931, 4379.
Decrease from last year, 14.2%.



New Orders for Steel Heating Boilers
In Square Feet of Heating Surface
May, 1932, 77,863; May, 1931, 189,195.
Decrease from last year, 58.9%.

Building permits for June showed a drop of 26.3% from May, according to data compiled by the Bureau of Labor Statistics, Department of Labor. Of the $49 million in permits for the month, $10 million were for new residential buildings, an increase of 0.3% over May, while $29 million were for non-residential buildings, a drop of 38.3% from the preceding month. The remainder was for alterations and repairs.

A peculiar feature of the permits for residential buildings is that while the value showed the slight increase mentioned above, the number of permits showed a decrease of 15.4%.

Poor's Index of General Business for June stands at 67.0 as compared with 66.2 in May, 65.3 in April and 61.6 in March, which was the lowest point of the depression thus far. The figures compare with a low in the 1921 depression of 79.9.

The index has thus shown improvement for the third consecutive month. The increase is not seasonal, for the index is corrected for seasonal trend. The publishers claim that the increase of their index while other indexes are still dropping is due to the fact that freight car loadings are not included. Poor's believes that the loss of freight to trucks in recent years has impaired the value of car loadings as an index to general business activity.

According to Paul Ryan, statistician of the American Gas Association, comparative statistics of 202 manufactured gas companies show an increase of 11.4% in the number of house-heating customers in April, 1932, as compared with the same month last year. The increase was from 46,077 to 51,331. New York utilities showed an increase of 20.8%, and Pennsylvania companies a rise of 19.8% in the number of customers now buying manufactured gas for heating buildings.

Employment in building construction increased 10.7% in April as compared with March, while earnings of employees increased 15.9% in the same period. This information is based on reports from 9875 firms, as reported by Federal agencies and by cooperating State departments.

The United States Government let contracts totaling $29.2 million for new buildings in May, as compared with $10.1 million in May, 1931. The various states let contracts in May

amounting to $2.7 million, as compared with $4.1 million for May in the preceding year. Consequently, the total of Federal and State building more than doubled since a year ago.

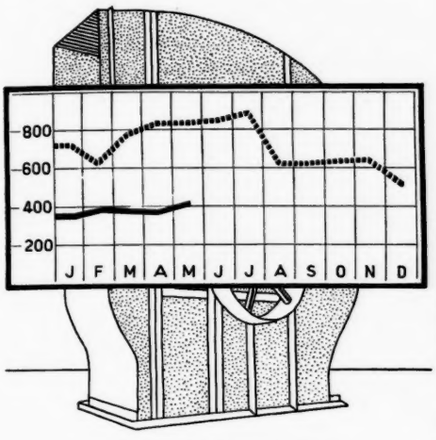
The first two weeks of July saw increased building activity and rising commodity prices after June had established a new record low point for industrial activity during the last 13 years, the Federal Reserve Board points out in its monthly survey of business conditions made public July 25.

million, an advance of about 7% over the total for the first quarter. For the first half of 1932 the contracts amounted to $100.4 million against $393.8 million for the corresponding half of 1931.

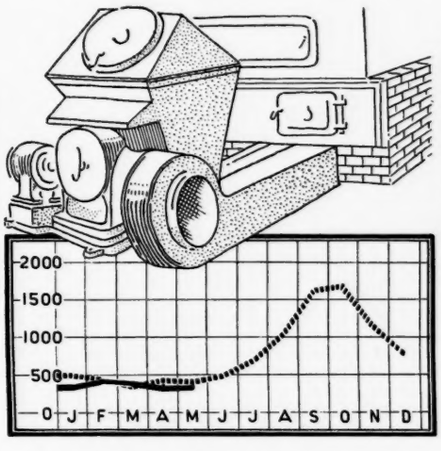
The offer made by Canada July 25 at the Imperial Economic Conference that she obtain a considerable portion of her coal from Britain holds much interest for the anthracite interests in Pennsylvania. By a trifling shift in the tariff, Britain can obtain about one-quarter of the coal orders now given to Pennsylvania. In 1931 Pennsylvania sold Canada coal valued at $15 million, so that the amount involved may amount to nearly $4 million at 1931 price levels.

The coal which would be obtained from Britain would be Welsh anthracite. The announcement recalls a bulletin of the Canada Department of Mines published in 1929 which showed that the average value of fixed carbon in the Welsh coal ran higher than that in the American anthracite. About 2% higher overall thermal efficiency was obtained with Welsh coal in a hot water boiler than was gotten with American anthracite.

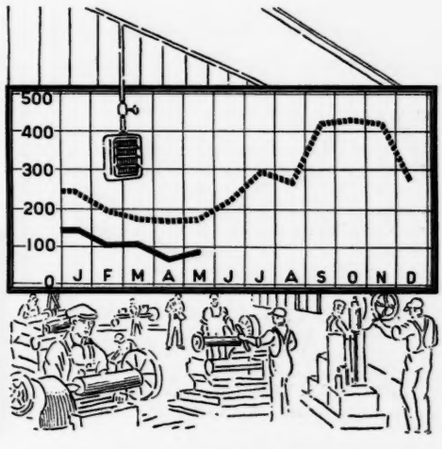
The wholesale price index of heating and plumbing materials shows an increase for June, rising from 64.4 in May to 66.7 for June. The increase can probably be ascribed to the seasonal increase in demand, but on the other hand it is interesting to observe from the chart that the increase in the corresponding month last year was less than this, and that in the years 1929 and 1930 there was a drop in the index from May to June. In view of these facts, the rise in the index can be viewed with at least mild optimism.



Fans and Blowers
Orders in Dollars
May, 1932, 413,684; May, 1931, 830,724. Decrease from last year, 50.2%.



Mechanical Heating Stokers
In Number of Units Installed
May, 1932, 342; May, 1931, 429. Decrease from last year, 20.3%.

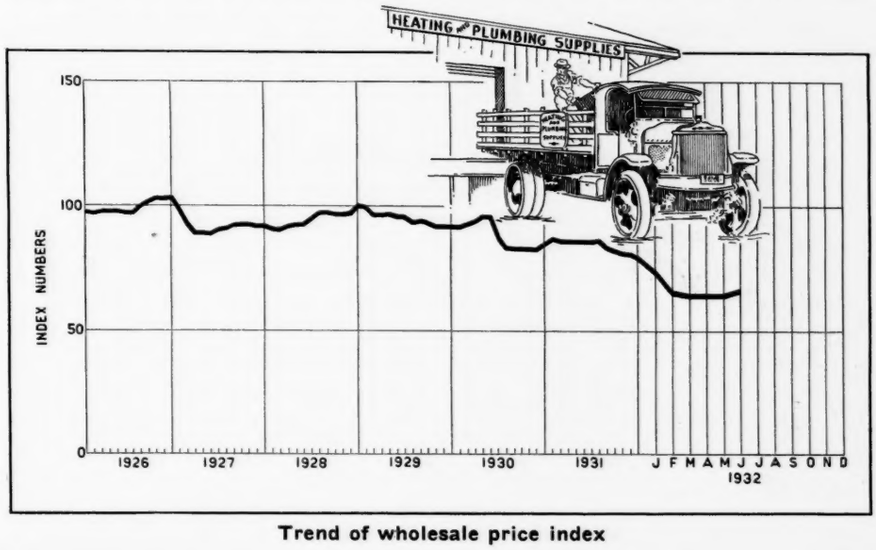


Unit Heaters (Industrial)
Orders in Dollars
May, 1932, 88,722; May, 1931, 173,724. Decrease from last year, 49%.

Dropping below the 1921 levels for the first time during May, the board's adjusted index of industrial activity, based on 1923-26 averages, fell another point in June and stood at 59 for that month. This is the lowest monthly average on the board records, which run back through 1919, according to information made available.

New construction contracts awarded in the metropolitan New York area for the first half of July totaled $5.6 million, as compared with $8.5 million for the first half of June, $18.6 million for the entire month of June and $62.9 million for June, 1931, according to figures compiled by the F. W. Dodge Corporation. Contracts on public buildings have shown a gain in recent weeks over the figures for a year ago, but all other classes have registered a decline.

The district showed a second quarter contract total of $51.8



Trend of wholesale price index

New Equipment

Ingoclad Two-Ply Stainless Steel

A two-ply stainless steel for commercial application has been developed by Ingersoll Steel & Disc Co., division of Borg-Warner Corp., Chicago. The product is to be known as Ingoclad stainless steel, and will be used in heating and ventilating ducts, and in fan, unit heater, air washing, and humidifying apparatus.

It is stated by the manufacturer that by the process used, a perfect bond between the stainless alloy and the carbon back is assured. It may be deep drawn, stamped, welded, and polished. Facilities will shortly be available for supplying all practical commercial gauges and sizes.

Durez Plastic Radiator Valve Knobs

Radiator valve knobs are being manufactured by the Diemolding Corp., Canastota, N. Y., from Durez, a phenolic plastic material which is a product of General Plastics, Inc., North Tonawanda, N. Y.

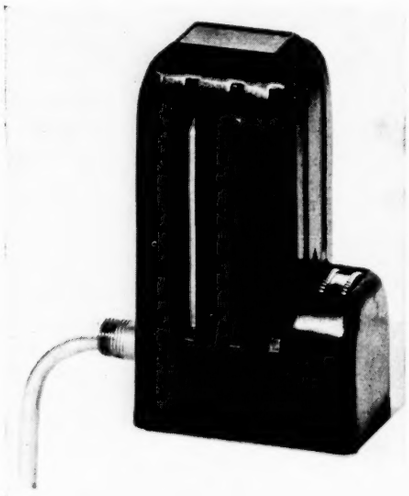
Among the advantages mentioned by the manufacturer are its strength and low degree of heat conductivity. It is also said that handles made of this material remain permanently lustrous and pleasing to the touch despite hard usage and high temperatures, and that they cannot chip, peel, or scratch.

Valve knobs of Durez

Shown inverted in the centre of the illustration is a radiator valve knob designed to fit any size of stem. The disc can be rotated to bring the desired hole into the center of the knob.

Dole Room Temperature Control Air Valve

A room temperature control air valve for one-pipe steam heating systems has been introduced by

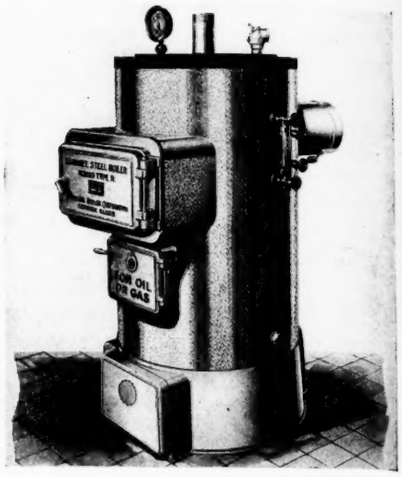


Dole R.T.C. air valve

The Dole Valve Co., 1913-1933 Carroll Ave., Chicago. The device will be called the Dole R.T.C. air valve.

Installation is the same as for any air or vacuum valve. A dial indicator can be set for any temperature between 60° F. and 80°. As soon as the room temperature reaches the point for which the control is adjusted the valve closes, entrapping air within the radiator, and thereby blocking off incoming steam. As the temperature of the room drops below the limiting point, part of the barrier of air is released from the radiator to permit the entry of more steam. This constant adjustment is automatic and maintains the temperature as set on the dial.

Valves are thermostatically actuated. All working parts are of durable metal, and the outer casing is of black Texolite, a plastic moulded product.



Kewanee round boiler

Kewanee Round Boilers

Kewanee Boiler Corp., Kewanee, Ill., has introduced a line of round steel boilers for domestic steam and hot water heating systems. They are available for oil or gas-firing, or for coal-firing.

The units are of one-piece welded steel plate construction, and are shipped ready to be set up on the assembled base. Door castings have gas-tight ground joints, and flue cleanout and furnace doors have refractory linings. Boilers are equipped with submerged domestic water heaters. An insulating jacket finished in baked enamel, encloses the boiler.

Units are made in two sizes, the smaller rated for 540 sq. ft. of direct steam radiation and the larger for 680 sq. ft. of steam radiation when oil or gas is burned. They are rated for 410 sq. ft. and 550 sq. ft. of direct steam radiation when anthracite coal is used.

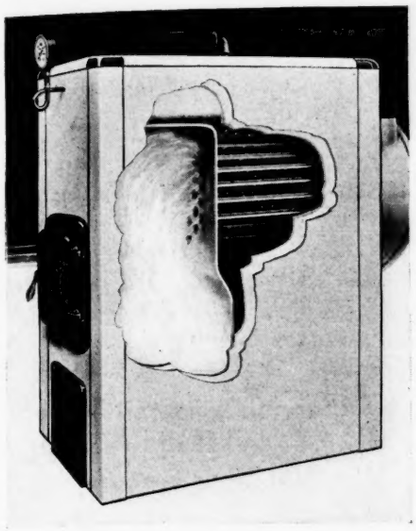
Fitzgibbons Oil Burning Boiler

Fitzgibbons Boiler Co., Inc., 570 7th Ave., New York, N. Y., has announced the Oil-Eighty automatic steel boiler for oil burning. It is for residential heating, and may be used with either steam or hot water systems.

Combustion takes place in a chamber sufficiently large to insure complete burning of the fuel and lined with ample radiant heat-absorbing surface. From the combustion space, the gases pass through a

bank of 1½ in. water-surrounded tubes which break it up into small streams to further heat transfer.

A combustion control device is



Fitzgibbons oil-burning boiler

located in the smoke box. This consists of a butterfly damper mounted on the outside end of a slotted thimble which can be adjusted in and out of the smoke box to provide the desired amount of slot opening to give the correct draft conditions required by the oil burner under the specific conditions of chimney and installation. This adjustment is made at the time of installation. From this point, instantaneous variations and fluctuations of the draft are compensated for by the butterfly damper, which opens by gravity against the external pressure to maintain the correct balance. Excessive internal pressures resulting from back-draft or an excess of oil are relieved by the damper, the frame of which is counter-weighted and is free to swing outward. This arrangement insures low draft resistance and balanced conditions even when the chimney conditions are bad, and compensates for changes which constantly take place within the firebox and chimney. It also provides an adjustable draft check and protects against backfiring.

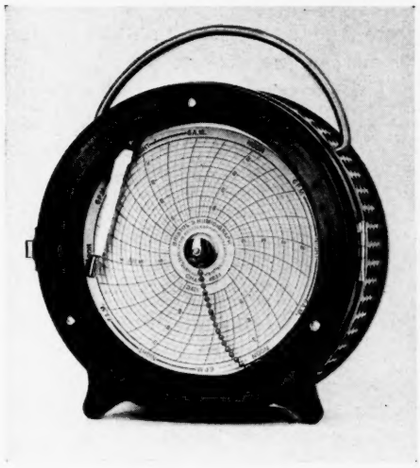
Designed for rapid water circulation, the boiler is said to be unusually quick-steaming. Large openings in the front and base of the boiler make installation and servicing of the burner convenient. A Fitzgibbons Tanksaver hot water supply coil is installed in the boiler when specified. This consists of copper tubing surrounded by the boiler water, and eliminates the necessity for a separate storage tank. The boiler is enclosed in an enameled steel-covered insulating jacket.

Boilers are manufactured in six sizes. The Steel Heating Boiler Institute ratings for the steam boilers range between 612 sq. ft. and 1513 sq. ft., and for the hot water boilers the ratings range between 979 sq. ft. and 2420 sq. ft.

Bristol Direct Reading Humidigraph

A direct reading recording hygrometer, called the Humidigraph, has been announced by The Bristol Co., Waterbury, Conn.

A hygroscopic measuring and actuating element, consisting of sensitive wood fibers built up on a nickel wire screen and wound in the form



Direct reading humidigraph

of a spiral, operates the recording arm. Deformations in this hygroscopic element caused by changes in relative humidity develop ample torque to permit the pen arm to be connected to it by a simple linkage, thus eliminating hair springs, rollers, and other delicate parts. It is said to be accurate and durable.

This instrument is available in round case models using 4 in. or 8 in. charts, and may be had in portable form or for surface mounting in some permanent location. A combination instrument may also be furnished for recording simultaneous readings of temperature and relative humidity.

Electric Grid Heaters

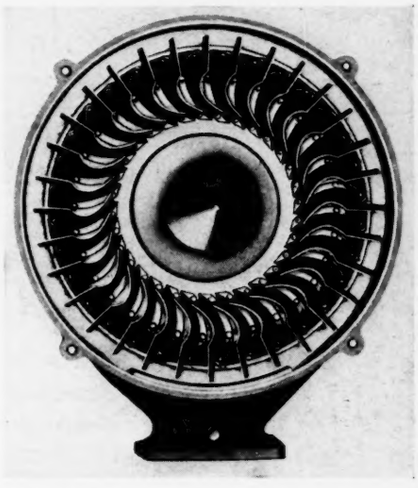
An electric unit heater is being marketed by The Soverhill Engineering Co., 2828 Pine Grove Ave., Chicago. Air is blown by a fan over grids which are warmed by an electric heating element. A thermostatic switching arrangement prevents overheating of the element, and a safety switch breaks the circuit when the motor is slowed up or stopped. Individually adjusted friction retained deflectors direct the discharge of heated air as desired.

Units are made in seven sizes, the capacities of which range between 17.1 sq. ft. to 2177 sq. ft. of equivalent direct steam radiation, with power inputs ranging between 1.2 kw. to 153 kw. Fan motors can be supplied to comply with any of the usual power services. Electric grid heaters are built in several other models, suitable for a variety of applications. These include the concealed types, gravity circulating units, and blast coil units, for installation in air ducts.

Dust Precipitator

A combined blower and dust collector has been announced by The American Air Filter Co., Louisville, Ky. The device is called the Turbo-Clone Dynamical precipitator.

A rotor, consisting of an inverted streamlined disc, carries a number of blades of such curvature that the dust is separated and precipitated and the clean air discharged all in one operation. The single stage machine is capable of producing a suction or pressure up to 20 in. water gauge. For higher pressures two or more units may be connected in series, or a multi-stage machine may be furnished.



Precipitator with scroll removed to show impeller

New Equipment

Dunham Heating and Air Conditioning Equipment

C. A. Dunham Co., 450 E. Ohio St., Chicago, has announced the Sav-T-heat gas-fired hot water heater, and an air conditioning unit for use in conjunction with it.

Heater units are made up of three essential parts comprising a generator, an economizer, and an exhauster. Combustion takes place in the generator (1), which is surrounded by copper coils through which the water of the heating plant circulates. The water in the jacket (2) which surrounds the generator is entirely separate from the water in the heating system. This jacket water is vaporized, and mixes with the hot gases of combustion at the top of the heater. The mixture thus formed is sufficiently high in vapor content effectively to eliminate the corrosion which often results from cooling the products of combustion from a gas flame to the condensation temperature.

This gas mixture enters the economizer (3) through which circulates the water from the heating system before it enters the coils in the combustion chamber. Since this is the coolest water in the heating system, a large quantity of heat is extracted from the vapor and gas mixture due to the increased temperature differential. After the original filling at the time of installation, the jacket water need not be replaced, since it is made up from condensation from the gas flame. Excess moisture added to the jacket water tends to wash impurities out through an overflow drain and to dilute the condensate to such an extent that there is no concentration of corrosive substances.

Mixture leaving the economizer is at a lower temperature than that of the stack gas of the usual gas appliance, but there still remains some usable heat. If the air conditioning unit is used in conjunction with the heater, the gases are passed through the two sections of heat transfer surface (4), which temper the air which is circulated by the conditioner. From here the gases pass to the motor-driven exhauster (5) which discharges them to the air at a temperature considerably lower than that of the water in the heating system, and the condensate from the gas-vapor mixture is returned to the jacket.

The air conditioning unit may be installed at the time the heater is put in, or it may be added at a later date, since the heater can be used independently. Air is drawn into the conditioner by means of two fan blowers, motor-driven through a V-belt. Entering air is passed through filter sections mounted in a drawer in the conditioning unit. Viscous-coated glass-wool filtering media are used. A humidifying pan extends the full length of the unit and is located directly in front of the fan discharges. A constant water level is automatically maintained and it is heated by a coil located in the generator. During the summer months the humidifying pan is drained, and cold water may be circulated in the copper fin-type radiator sections which are used for warming during the heating season. The fan speed may be adjusted by means of a three-step pulley on the motor shaft.

This equipment is made in four sizes. These are rated for capacities of 535 sq. ft., 800 sq. ft., 1067 sq. ft. and 1334 sq. ft. of direct steam radiation. Gas input ranges between 100,000 B.t.u. per hour for the smallest size to 250,000 B.t.u. per hour for the largest boiler.

Expansion Joint for Flues and Ducts

Bergen Point Iron Works, Bayonne, N. J., is manufacturing an expansion joint for use in flues, ducts, and similar applications, which permits expansion and contraction of the flue without rupture or distortion of the metal.

An asbestos lining (2) riveted to a spring clip (1) is held against the angle (4) by the bolts (3). The angle is fastened to the flue by bolts passing through slots, permitting the joint to shorten or lengthen sufficiently to prevent damage. It is said by its manufacturer to be gas-tight.

Joints are made up as a complete unit in the factory and are bolted or riveted to the flue in the field. They may be had for flues having rectangular, round, or irregular sections.

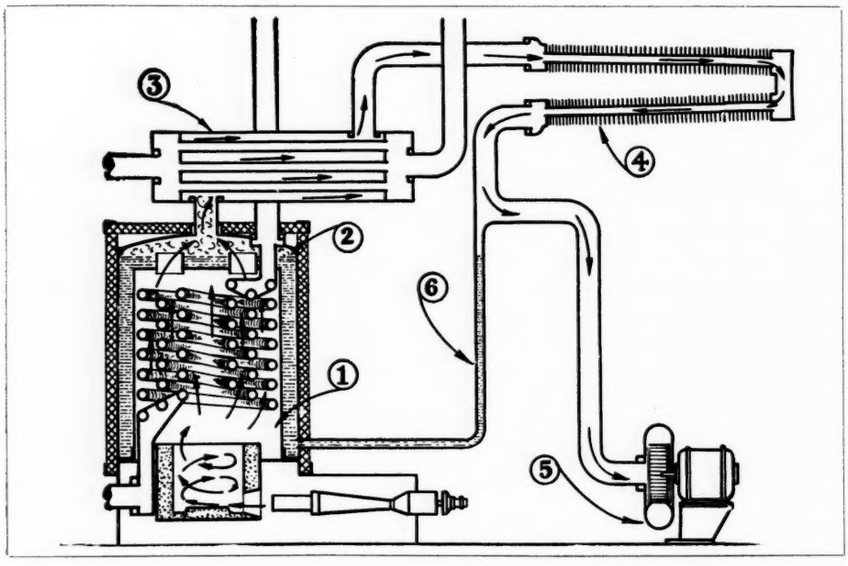


Diagram of Sav-T-heat system showing path of hot gases

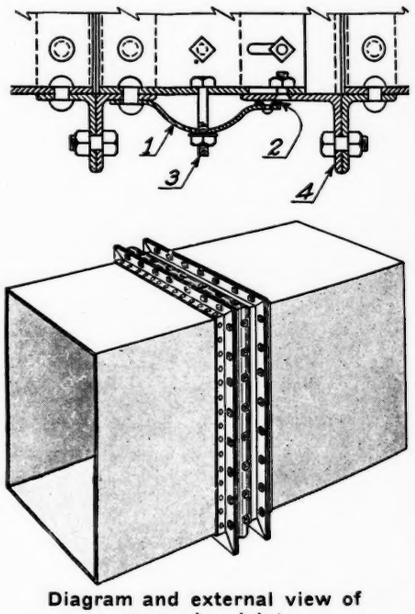
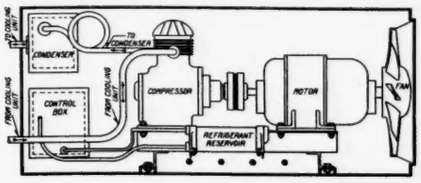


Diagram and external view of expansion joint



(Left) Air cooling equipment suspended beneath car. (Above) Diagram of air cooling apparatus

Car Cooling Equipment Manufactured by Westinghouse

Air conditioning equipment for cooling railroad cars is being manufactured by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Units consist of a self-contained high-speed motor-driven compressor, mounted with a condenser in a box suspended beneath the car. Power is supplied by generators gear-driven from the axles. These generators have been designed to provide sufficient capacity to carry the car lighting, battery charging, and air conditioning loads, and deliver current at constant voltage at train speeds of from 20 m.p.h. to 90 m.p.h. The compressor and condenser are cooled by a fan mounted on the motor shaft.

A switching arrangement permits the cars to be cooled in the yards previous to starting by plugging the system into an existing alternating current supply. While this is taking place the batteries may be charged without altering the connections. When the cooled train is ready to start, the apparatus can be switched over to the direct current supplied by the batteries carried on the cars.

Ten 6-ton units are being installed on cars of the Illinois Central Railroad to be put in service on daylight trains operating between Chicago and St. Louis.

Perkheater Hot Water System

Hitchings & Co., Elizabeth, N. J., has developed the Perkheater hot water heating system, in which the boiler can be placed on any desired grade or elevation, thereby eliminating the necessity for a boiler cellar. The manufacturer recommends it for greenhouse or residential heating.

A tank is placed over the boiler with its bottom higher than the mains and radiation. This tank is divided into an upper and a lower section, with no direct water connection between them. A pipe from the top section leads to the mains and radiation, and the return is brought

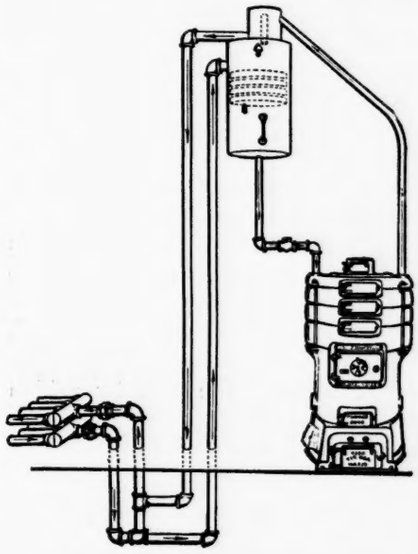
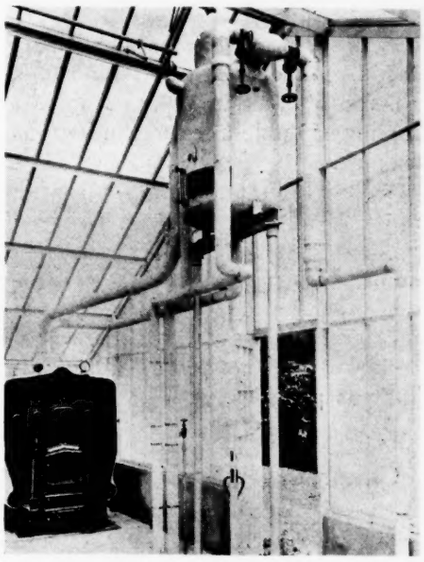


Diagram of Perkheater system

into the lower part of the tank. The lower part of the tank is equipped with a gauge glass and replaces the usual expansion tank.

When water in the boiler reaches the boiling point, water and steam



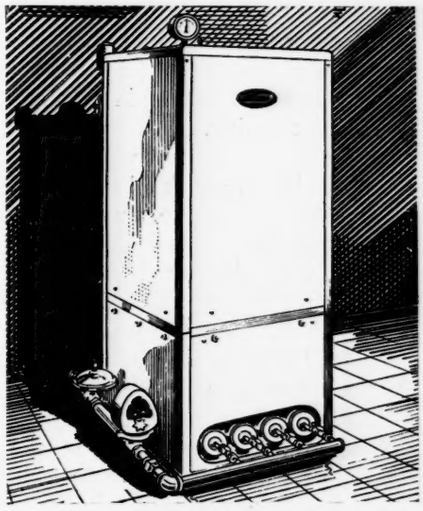
Greenhouse installation with boiler on grade

pass into the upper part of the tank, and is replaced by water from the lower section of the tank. The water is separated from the steam in the top compartment and the water passes out through the pipe to the radiation. The steam is passed into the lower compartment where the return water condenses it.

Circulation through the mains and radiation is accomplished by the positive head existing by reason of the difference in level between the surface of the water in the top section of the tank, and the top of the return pipe. The manufacturer asserts that this head is several times greater than that set up in the usual gravity system, and that smaller mains may be used as a result.

McCormick Gas Boiler

J. H. McCormick & Co., Williamsport, Pa., has announced the McCormick High Speed gas-fired boiler for domestic steam and hot water heating systems.

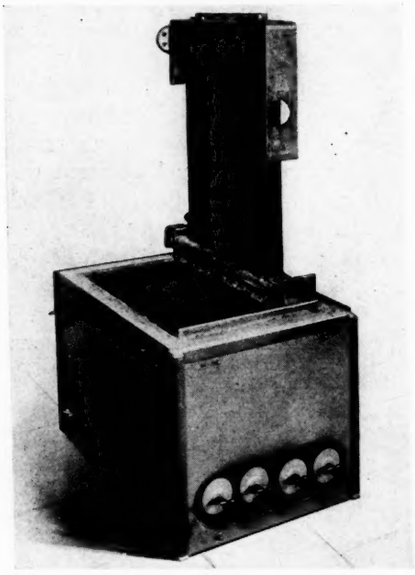


McCormick gas boiler

Units are made up of sections consisting of double steel tubes, set concentrically one within the other and welded to top and bottom headers. Between the walls of the tubes is a water space 9/64 in. thick. In each section, consisting of six of these double tubes, there are but 2.3 gal. of water, and in a complete four-section boiler there are but 18 gal., about half of which is in the make-up tank.

Heat from the burner is concentrated on the shallow bottom header,

and causes rapid circulation of water up through the water columns. The hot gases from the burner pass up through the inner tubes, over baffles in the dome, and down the outside



Jacket removed, showing one section in place

of the outer tubes. Thus heat transfer takes place on two sides of thin water columns, resulting in extremely rapid steaming.

Burners are equipped with a mixer adjustable to any kind of gas. A large chamber in the burner dissipates the gas pressure so that the fuel is delivered through deep nozzles with no pressure behind it. This eliminates the explosive noise on ignition and shutting down, and completely silences combustion when the burner is in operation.

Steel is used throughout in the construction, and all parts are made to fit accurately together. There are no bolts used in assembling the units above the base. Insulation consists of 2½ in. of rock wool compressed to 2 in. between the walls of the jacket, leaving a bulge at each end. These bulges are brought together, forming a tight joint at the corners and preventing heat leakage.

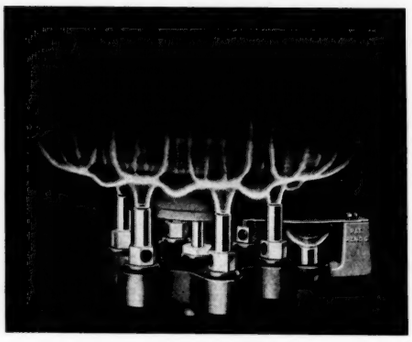
Eighteen sizes of boiler are made for both steam and hot water. The net ratings of the steam boilers including pipe losses range from 340 sq. ft. to 2025 sq. ft. of direct steam radiation. The hot water boilers range in net rating from 540 to 3225 sq. ft. of radiation.

Barber Gas Burners

The Barber Gas Burner Co., 3702-3704 Superior Ave., Cleveland, has introduced the Barber slotted cap, and the Barber Bell baffle burners, for domestic and industrial gas-fired appliances. Both types may be equipped with safety pilot control.

Jets for both burners are made of ½ in. alloy rod brass and are screwed into a manifold of automobile cylinder iron having machine-faced bosses to prevent flame irregularities. The jets have been designed with regard to correct proportioning for the combustion of natural, manufactured, or mixed gas fuels. Pilot jets are also made from ½ in. alloy rod brass stock. A ⅛ in. threaded male connection is provided to accommodate a standard tubing connection to the pilot.

A tobin bronze plunger valve is actuated by a bi-metallic element to close the main gas inlet in the event of the pilot becoming extinguished. This element is protected from the direct flame of the pilot by a high



Barber burner

temperature corrosion - resisting shield. When the main burner is on, the plunger valve seats against a plunger guide cap, preventing gas leakage.

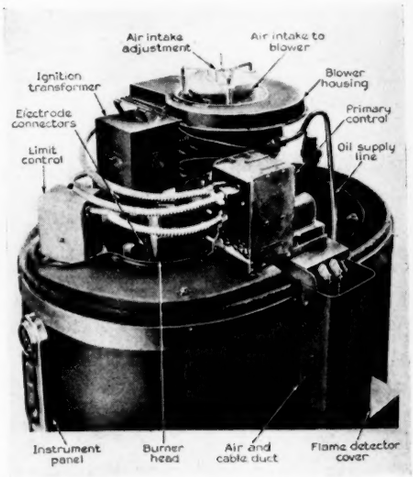
Units are manufactured in a wide range of sizes for both types. The smallest of these burns 9 cu. ft. of natural gas per hr., at 3½ in. pressure, and the maximum capacity of the largest burner is 93 cu. ft. of manufactured gas per hr., at a similar gas pressure.

General Electric Oil Burning Equipment

Announcement of a coordinated boiler, oil burner, and control, designed and manufactured as one unit, has been made by General Electric Co., Schenectady, N. Y. The heater is primarily intended for domestic use, and is applicable to both steam and hot water systems, or it may be used to supply steam as the heating medium for warm air systems. For the latter purpose, an air conditioning unit is available.

Boiler and combustion chamber are housed in the lower part of the heater, and the oil burner and controlling devices are located in the insulated upper section. The oil burner nozzle and the electrodes for the electric arc ignition extend down into the combustion space through sealed openings, and a tightly fitting cover is placed over the entire mechanism. Air for combustion is drawn into this space through louvers in a duct extending along the right side of the boiler. The pressure in the upper compartment is in this way maintained at less than atmospheric, which precludes any possibility of an odor of oil entering the basement. This cover and air duct arrangement is said effectively to silence the operation of the burner and blower.

Atomized oil is blown under pressure from the nozzle toward the bottom of the unit. A small quantity of air is fed in around the nozzle, cooling the nozzle and electrodes and starting the combustion at a point some distance from the nozzle. The major part of the air, however, is introduced by the blower through a duct in the left side of the boiler, and enters the bottom of the combustion space, moving in an upward direction. This meeting of the burning oil vapor spray with the



Burner and control mechanism with cover removed, G.E. oil heater

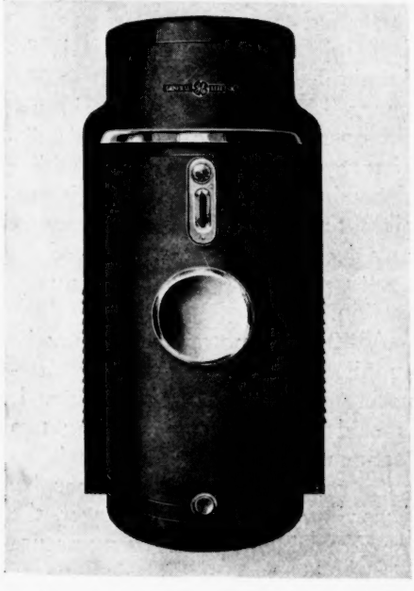
secondary air supply results in a diffused flame which spreads out at the point where the secondary air is encountered and passes upward in contact with the refractory lining of the walls. This combustion path is nearly twice the length of the chamber, and it is said that the oil is completely burned before leaving the space. The fine atomization makes possible the use of No. 3 oil.

After passing to the top of the combustion chamber, the products of combustion traverse a short lateral pass and down over the boiler tubes, entering the chimney stack at the bottom of the boiler. Combustion spaces are entirely surrounded by boiler water, and the progress of the combustion and its products is such that the gases are hottest where the water is hot, and have given up most of their heat when they reach the points where the water is coldest.

When used in a hot water heating system a water circulator is specified. This consists of a motor-driven pump, thermostatically controlled, which provides for prompt response to heating demands, and also prevents the circulation of hot water into the heating system when the burner is operating to supply domestic hot water only.

For application to warm air heating systems the G-E air conditioner is used in conjunction with the boiler. Steam from the boiler is passed through an extended heat transfer surface, and as the air is circulated through the air conditioner it is warmed, filtered, and humidified. Positive circulation is provided by a blower in the air conditioner. This apparatus also is automatically controlled, a thermostat starting and stopping the blower simultaneously with the oil burner. The manufacturer states that overshooting of the room temperature is impossible, since the heat delivery stops immediately when the blower is shut down. A humidistat regulates the operation of the humidifier in the air conditioner. This use of steam for the heating medium in the warm air system is recommended by the manufacturer because it eliminates any possibility of flue gas leakage into the living quarters, makes possible a more compact construction, and because the boiler may be located at the point most convenient for the chimney connections and the air conditioner placed where the basement leader system may be brought most conveniently to a common junction.

Maximum output of heating unit is given as 257,000 B.t.u. per hour.



General Electric oil-burning boiler

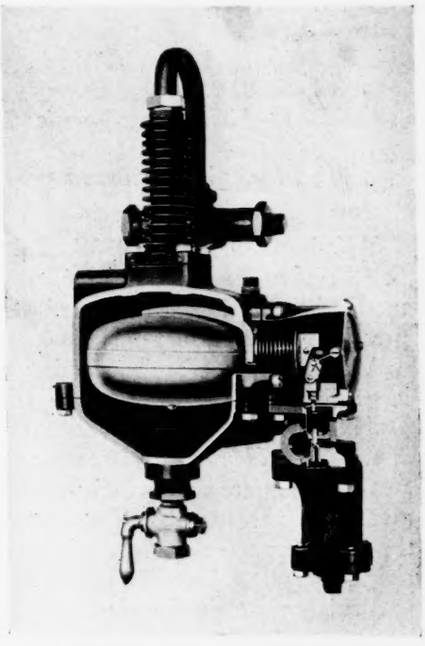
Seismo-Damper isolator

Seismo-Damper Machinery Isolators

A machinery isolation device, called the Seismo-Damper, has been introduced by The Korfund Co., Inc., 4815 Thirty-second Place, Long Island City, N. Y.

It consists of an arrangement by which any isolating material, such as cork, rubber, or similar substance, is inserted between an upper and a lower housing. In order that the isolating material will be subjected to the proper pressure intensity for maximum efficiency, it is preloaded at the factory to that point which compensates for the difference between the loading established by the machine to which it is to be applied, and the loading required by the material for maximum efficiency.

Upper housings are drilled and tapped for bolting directly to the base or leg of the machine. The device can be supplied to meet practically every requirement.



Cut-away view of safety feeder

Safety Feeder for Small Boilers

McDonnell & Miller, Wrigley Bldg., Chicago, has announced the No. 37 safety feeder for boilers of under 2500 sq. ft. capacity.

This device is installed in the gauge cock tappings, and must therefore duplicate the gauge glass conditions within its float chamber. The gauge glass that has been thus displaced is then installed on the feeder, which has tappings to accommodate it. The bent tube by which the upper connection is made is adjustable up and down, so that the device will fit boilers having any length of gauge glass.

A float operates the valve which admits cold water to the boiler. The float is set to maintain the water at a level 1 in. above the bottom of the gauge glass. The valve is separated from the heat of the float chamber by a sufficiently large ventilated space to insure that the temperature at the valve will remain below the point at which lime and scale are precipitated out of the water. This prevents sticking and binding of the feed valve. Sylphon bellows are used instead of stuffing boxes, insuring a tight seal between the float

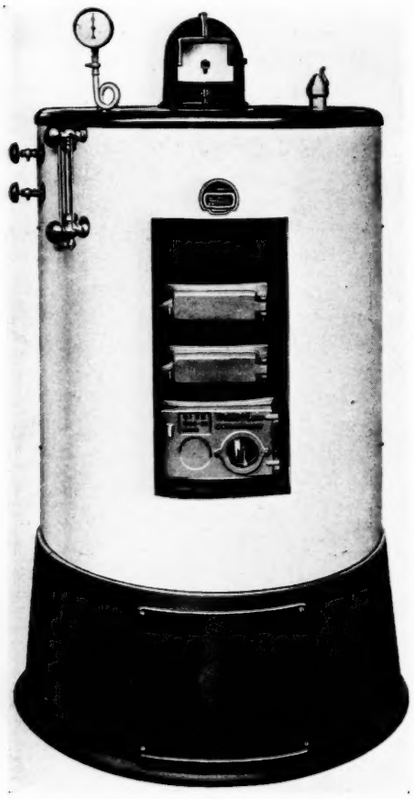
chamber and the lever compartment and between the lever compartment and the feed valve.

Valves are of hardened stainless steel, and a strainer of ample size gives added protection to the feed valve. When the feeder is used with an oil burning boiler it is recommended that a low-water cut-off switch be used in conjunction with it.

Weil-McLain Oil Burning Boilers

Weil-McLain Co., 641 W. Lake St., Chicago, is manufacturing domestic heating boilers designed expressly for oil burner installations.

A combustion chamber having a large diameter and extended hearth provides for complete combustion of the fuel. Heating surfaces in the steam boilers are corrugated to promote heat absorption by increasing the heat transfer surface. Water channels are of liberal dimensions, particularly surrounding the combustion chamber, to give quick circulation. Sections are so designed as to give a long fire travel before the products of combustion are delivered to the chimney.



Weil-McLain oil-burning boiler

Boilers are encased in an enameled steel jacket and insulated with a lining of silica wool. The fire door is provided with an observation port. Four sizes are made for both hot water and steam systems. Hot water boilers range in capacity from 1275 sq. ft. to 2000 sq. ft. of equivalent direct water radiation at the maximum heat transmission rate, and steam boilers range between 800 sq. ft. and 1250 sq. ft. of equivalent direct steam radiation.

Petro Oil Burners

Petroleum Heat and Power Co., Stamford, Conn., has added two domestic oil burners to its line of Petro-Nokol burners.

In Model W-1, the smaller of the burners, the fuel oil is introduced into a rapidly revolving cone-shaped cup in which it is reduced to a thin film before reaching the edge where centrifugal force breaks it up into minute particles. Air from the fan is passed through the nozzle of the burner and out over the edge of the revolving cup, where it encounters oil flowing in the opposite direction. This results in a turbulent combustible mixture, which burns in suspension to an incandescent hot gas.

By shifting the adjustable nozzle or by substitution of a different nozzle the type of flame can be regulated to comply with the type best adapted for any particular kind of boiler. An adjustment built into the burner permits regulation of the air and oil mixture ratio. Ignition is provided for by a gas pilot.

One-half to 1½ gal. of No. 3 fuel oil are burned per hour by the W-1 burner, and its capacity ranges from 175 sq. ft. to 525 sq. ft. of direct steam radiation, or 280 sq. ft. to 840 sq. ft. of hot water radiation.

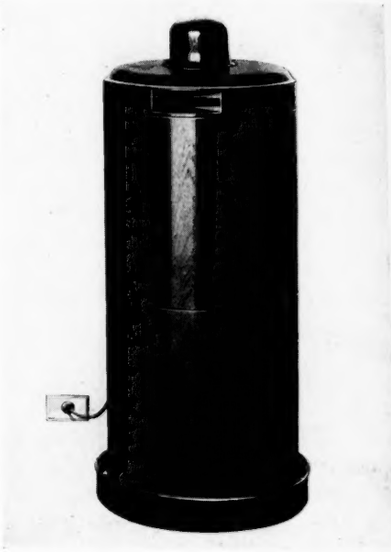
Model P-1½, the larger burner, has motor, fan, and oil pump mounted as a single rotating unit. Vanes in the end of the nozzle impart a rotary motion to the air just before it reaches the point at which the oil is introduced from an atomizing jet.

Model P-1½ burns from 2 gal. to 5 gal. of No. 3 oil per hour, with a capacity of from 700 sq. ft. to 1750 sq. ft. of direct steam radiation, and from 1120 sq. ft. to 2800 sq. ft. hot water radiation capacity.

Modine Ice-Fan Room Cooler

Modine Mfg. Co., Racine, Wis., is marketing the Ice-Fan room cooler, a device for comfort-cooling homes, hotel rooms, offices, and similar applications.

This cooler consists of an ice storage cabinet having an electric blower at its top. The ice cabinet is made up of cylindrical sections, and one, two, or three of these sections may be used, depending upon the requirements of the space to be cooled. Each section is separately charged with ice.



Ice-Fan room cooler

Air from the room is drawn in at the bottom and passes upward through the passages in the ice sections where it is cooled and dehumidified. The base of the cooler is shaped to collect the water which is condensed out as the air is dehumidified. The cooled air is discharged back into the room through an opening at the top. This discharge opening is equipped with a deflecting vane which makes it possible to direct the cold stream at any desired level and the top of the cooler may be revolved in any direction.

A 30-watt motor which may be supplied for either direct or alternating current drives the blower. It is said that the cooler, using two sections of ice cabinet will melt ice at a rate of about 20 lb. per hr. According to the manufacturer, the Ice-Fan will lower the temperature of the air passing through it by as much as 25° F.

With the Manufacturers

Corporation Being Formed to Sell Ready-Made Steel Houses

Plans are in progress for the formation of General Houses, Inc., an organization which will manufacture, market, and finance ready-made pressed steel houses. The houses, plans for which have already been completed by Howard T. Fisher, Chicago, have either five or six rooms, are one story in height, have flat roofs and numerous windows. They will be sold completely equipped with electric refrigeration, heating apparatus, plumbing, and wiring, and the cost is expected to be $3500 and less.

Merchandising methods similar to those employed in the marketing of automobiles will enable the purchaser to pay for his home in $30 monthly installments. It is said that the houses will have trade-in value, and may be exchanged for newer models. It is expected that the dwellings will be retailed through agency dealers. Such a scheme would put an end to the present financing system for small houses, and substitute a simplified one-mortgage plan that would eliminate the second mortgage entirely.

Although the corporation has not yet been financed or brought to the point of operation, a number of manufacturers of materials and equipment have been conducting investigations into the various engineering and commercial problems of the project.

General Houses, Inc., is said to have enlisted the aid of the American Radiator & Standard Sanitary Corporation, Pullman Car & Manufacturing Company, Concrete Engineering Company, General Electric Company, Pittsburgh Plate Glass Company, Container Corporation of America, and Thomas E. Edison, Inc., for various engineering and commercial studies necessary to the project.

Hot-Kold Sold to Edwards Manufacturing Company

Announcement has been made by Chas. Eisen, receiver for The General Iron Works Co., Cincinnati, that the Edwards Manufacturing Co., Cincinnati, has completed negotiations for the purchase of the good will, patents, and physical assets of the Hot-Kold air conditioning system, formerly manufactured by The General Iron Works Company.

Morris Floyd, who has been sales manager for The General Iron works Company, will be in charge of the newly-organized heating department of the Edwards Manufacturing Company.

Kurtz New President of Stoker Association

Harry H. Kurtz, manager of the Iron Fireman Mfg. Co., Chicago, was elected president of the Mid-West Stoker Association at the annual meeting in Chicago, July 11. T. A. Marsh, president of the Modern Coal Burner Co., Chicago, was named vice-president of the association, and Arthur R. O'Dell, manager of the Chicago office of Combustioneer, Incorporated, was chosen as secretary and treasurer.

E. L. Beckwith, manager of the Chicago office of the Detroit Stoker Company; James W. Anderson, of Willian Less, Inc., Chicago; and Ray C. Goddard, retiring president, were elected to the board of directors of the association.

New England Wholesalers Organize

Wholesalers in plumbing and heating supplies in New England have formed an association to be known as the Plumbing and Heating Wholesalers of New England, Inc. Eligibility for membership in the organization is confined to those wholesalers now operating in this section.

M. W. Dennison, Bramen Dow Co., Boston, is the first president of the association. Other officers are: T. H. Dawson, Jr., Crane Co., Boston, vice-president; H. W. Thorndike, F. W. Webb Mfg. Co., Boston, treasurer; Edmund F. Butler, with headquarters at 107 Arlington St., Boston, executive secretary. The association held its first meeting at Watch Hill, R. I., on June 27.

Specifications for Gray Iron Revised

As a result of several years of research by the Gray Iron Institute, Cleveland, Ohio, the old Specification for Gray Iron Castings, known as A48-29T has been revised by the American Society for Testing Materials to a tentative form known as A48-32.

Gray iron castings are classified into seven groups under the new specification. These classes range between 20,000 lb. per sq. in. to 60,000 lb. per sq. in. minimum tensile strength. A second new provision specifies that standard test bars of 0.875 in., 1.2 in. and 2.0 in. diameter shall be used to provide adequate design information pertaining to various critical sections in castings. Formerly but one size of test bar was standard.

It is believed that it will now be possible for foundrymen to state specifically the strength which can be expected in ciritical sections of their castings throughout the whole range of section sizes. A certification plan is being worked out whereby any foundry submitting its iron to suitable tests and metallurgical inspection can certify that its product fulfills the requirements for one of the above classes. Copies of the tentative specifications are available from the institute, and criticisms of them in their present form are solicited.

Oil Burner Credit Association Formed in Detroit

Manufacturers and dealers selling nationally known makes of oil burners have organized the Oil Burner Credit Association of Detroit in order to avail themselves of credit information for their mutual protection. Officers elected at the first regular meeting are: president, Arthur E. Parney, Automatic Heat Corporation; vice-president, William S. Turner, Timken Silent Automatic; secretary, Walter A. Hoffman, Bureau of Credits.

With the Manufacturers

Manufacturers Entering Air Conditioning Field in Large Numbers

Manufacturers in other fields are turning in wholesale numbers to the air conditioning field as a possible market during the present stagnation of business. The entrance of General Electric into the field was followed by an announcement that the Rudolph Wurlitzer musical supply stores would sell air conditioning equipment in their branches. Concerns already known in the heating field, such as the Chicago Pump Company, have announced ice room coolers, while C. A. Dunham Company has placed a new unit on the market to humidify in connection with a gas-fired heating unit. General Motors has finally actively started a campaign on its oil burner. Fairbanks-Morse recently announced apparatus for railway car cooling, while Foster-Wheeler has developed a steam ejector system of refrigeration.

Following along the lines of American Radiator and Crane Company in bringing out their humidifying radiators, Richardson & Boynton have placed such a unit on the market. Barber-Colman Company, well known as precision machinery builders, both in the machine tool and textile machinery fields, has been engaged in developing its market for air conditioning controls. Owens-Illinois Glass Company some months ago entered the field with a filter. Several dozen warm-air furnace manufacturers are selling domestic heating and conditioning units. Frigidaire Division of General Motors is advertising a room cooler. Whitehead & Kales, founders and manufacturers of steel structural work, are engaged in developing a humidifier. Dail Steel Products Company, makers of tanks and chemical products, are marketing a domestic heating and conditioning system. A. C. Gilbert, who made the Erector sets for boys nationally known, has for some time been selling a room humidifier.

Bureau to Sponsor Use of Ice for Cooling

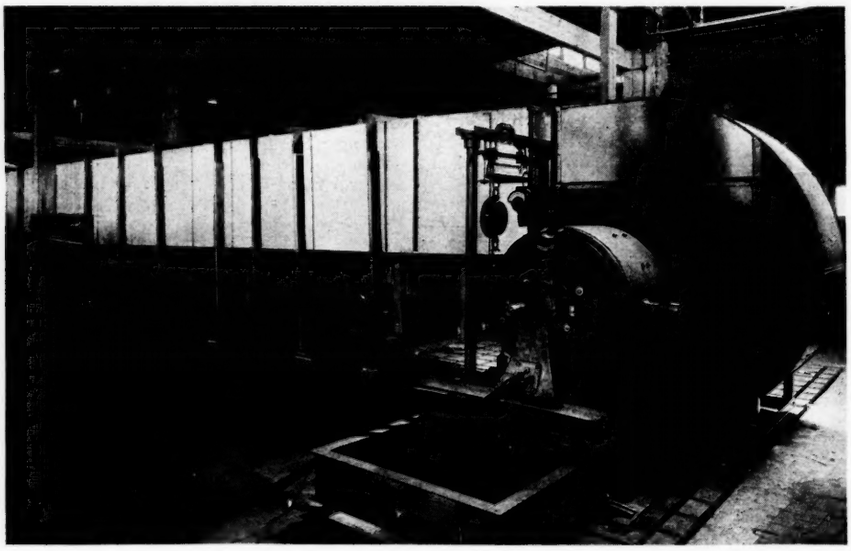
To introduce and sponsor the sale of comfort cooling systems using ice as a cooling medium is the purpose of a new bureau organized and sponsored by the ice manufacturers of Detroit. Under the name of the Detroit Ice Publicity Association, these manufacturers have been organized for more than three years, and the establishment of the new comfort cooling bureau manifests their belief in comfort cooling in the ice field.

In addition to directing their efforts toward the comfort cooling idea, a research division is devoted to finding and promoting new uses for ice and improving existing uses. Working in cooperation with the bureau as consulting engineers will be the George B. Bright Company, in whose experimental laboratories tests and experiments will be carried out on any new principles or devices, several of which are under development. Mr. Bright will also serve as consultant on any engineering layouts to insure such ice jobs as are installed being correctly designed.

The bureau maintains an office and display room where there will be in operation a comfort cooling system in addition to a display of all sorts of apparatus and cooling devices using ice. At this central point, heating and ventilating contractors, engineers, architects and the general public can see the entire story of the ice method and its advantages properly presented.

The bureau is headed by William W. Watson, formerly of Kilner-Mills Co., Detroit, who acts as field engineer and representative. The affairs of the bureau are directed by an advisory committee of the Ice Publicity Association, consisting of A. G. Leoffel, Detroit City Service Company, A. J. Cordrey, Borin Brothers, and Robert Girvin, Pittman and Dean Company.

The purpose of the bureau is mainly to coordinate the efforts of vendors of apparatus, the contractors, the ice companies, the power company and the customer's interests. The bureau does not engage in the sale of any products, but serves only to promote and spread the idea of comfort cooling with ice.



Test set-up in laboratory of the Buffalo Forge Co., Buffalo, N. Y.

Walworth and Merco Nordstrom Agree on Patents

It has been announced that the patent litigation relating to lubricated plug valves that has been pending between the Merco Nordstrom Valve Co., 343 Sansome St., San Francisco, and the Walworth Co., 60 East 42nd St., New York, has been averted through the entry of consent decrees and a cross-licensing arrangement, under which each has recognized the validity of the patent rights of the other. Litigation was terminated upon the urgent advice of counsel for both companies.

With the Manufacturers

Mason Regulator Co., Boston, manufacturers of automatic regulating and control equipment, announce the appointment of the O'Brien Steam Specialty Co., Syracuse, New York, as exclusive representatives for western and northern New York state. The O'Brien Steam Specialty Co. has offices in Syracuse, Rochester and Niagara Falls.

Youngs Cornell Utilities, Inc., Long Island, N. Y., has been appointed distributor in Nassau County, L. I., for the General Motors Delco Heat oil burning equipment. Offices will be maintained in Rockville Center and Great Neck. W. T. Burtis was recently appointed associate dealer operating from Glen Head, L. I.

Young Radiator Co., Racine, Wis., announces the appointment of L. M. Young as works manager in charge of the manufacturing plant and development work covering the engine cooling division and heating division.

Lakeside Co., Hermansville, Mich., announces the appointment of Guy Voorhees, who will cover the Indiana territory as sales engineer, with headquarters in Indianapolis. Mr. Voorhees is the twenty-seventh direct factory representative appointed by the company.

The Air Conditioning & Engineering Co., 3331 Rutger St., St. Louis, Mo., has appointed the Wagner Peterson Corp., 53 Fourth St., Portland, Ore., as its representative in Washington and Oregon. J. M. Robb, 1513 Columbia Terrace, Peoria, Ill., is now the company's representative in Knox, Peoria, Tazewell and McLean Counties in Illinois.

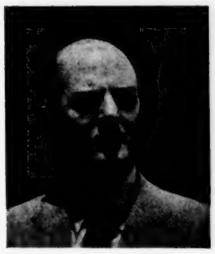
McDermott Water Heaters, Inc., 101 Park Ave., New York, N. Y., has issued a circular describing coil tanks for residential hot water supply. Contains engineering data, specification form, ratings, tables, dimensions, and prices. Twelve pages, letter-size, illustrated.

J. H. McCormick & Co., Williamsport, Pa., announces the appointment of H. H. Dodge as chief engineer of the Company's Gas Division, in charge of development of the McCormick gas boiler announced

(Left) H. H. Dodge, chief engineer, Gas Division, (Right) R. P. Clarkson, chief engineer, Airtrol Division, J. H. McCormick & Company

recently. Mr. Dodge previously was chief engineer of the Sweet & Doyle Foundry & Machine Co., and was connected with the development of that company's gas conversion unit.

The company has appointed W. H. Campbell as vice-president in charge of sales with headquarters at Room 703, Chrysler Building, New York. Mr. Campbell formerly was connected with the Filtrine Mfg. Co., Brooklyn, and previously was Eastern Division Manager of the Servel Co.



W. H. Campbell

M. N. Dunning has been appointed as sales engineer by the company with headquarters in New York.

The Bishop & Babcock Sales Co., 4901 Hamilton Ave., N. E., Cleveland, Ohio, announces the appointment of Mayer Godchaux, 2234 State St., New Orleans, La., as its representative in that territory.

National Radiator Corp., Johnstown, Pa., announces the appointment of Carl A. Sawade as assistant general manager of sales.

In his new capacity, Mr. Sawade will continue in charge of sales promotion activities, and will be primarily concerned with the intensive working of the home modernization market.

The company also announces the appointment of Paul J. Bracken as Ohio district manager, with headquarters in Cincinnati.

The American Rolling Mill Co., Middletown, Ohio, has published Bulletin No. 9, on the "Uses of Plate Metal in Mechanical Equipment." It contains descriptions of applications of Armco Ingot iron and Armco steel plates and sheets in the Cincinnati & Suburban Bell Telephone Company Building. Also contains tables giving widths and lengths of these products for various thicknesses and gauges. Standard size, eight pages.

Mason Regulator Co., 1190 Adams St., Boston, Mass., has opened a new office in Chicago at 1525 East 53rd Street. William P. Gearon will be in charge.

Kennedy Valve Mfg. Co., Elmira, N. Y., announces that its new Chicago branch office and warehouse at 1306-1312 South Canal Street has been made a central distributing point to the 11 middle western states.

The Bethlehem Foundry & Machine Co., Bethlehem, Pa., has acquired control of the Oil-Elec-tric Engineering Corp., Minneapolis, Minn., makers of the Doe Oil-Electric burner, which will now be manufactured at the Bethlehem plant.

Rome Radiation Co., division of *Revere Copper and Brass Inc.*, Rome, N. Y., has appointed Charles J. Bushong, 304 Forster St., Harrisburg, Pa., as its representative in the sale of the company's convectors in the south central counties of Pennsylvania.

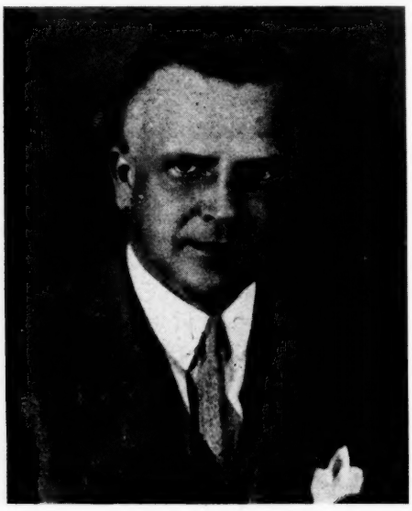
The Youngstown Sheet and Tube Co., Youngstown, Ohio, has appointed Lew E. Wallace as New York district sales manager. Mr. Wallace, who will succeed W. B. Blowers, was assistant manager of pipe sales for the past several years.

The Ideal Electric & Mfg. Co., Mansfield, Ohio, has issued Bulletin No. 210 containing details on the design, characteristics, and construction of the Noel polyphase capacitor motor. Standard size, 19 pages.

Croll-Reynolds Engineering Co., Inc., 17 John St., New York, has issued Bulletin 40-A, illustrating and describing its FlexoDisc expansion joints. Data are included for estimating expansion and contraction of various kinds of pipe. Eight pages, standard size.

With the Manufacturers

Petroleum Heat and Power Co., Stamford, Conn., announces the appointment of John B. Allington as director of the company's gas equip-



John B. Allington

ment and gas air conditioning division. Mr. Allington is now developing a new line of air conditioning furnaces for either oil or gas fuel.

L. J. Wing Mfg. Co., 154 West 14th St., New York, has issued bulletin T-97 describing Wing turbine blowers. Contains data and engineering information on the use of blowers for forced draft service with hand-fired, stoker-fired, and oil-fired boilers.

Revere Copper and Brass Inc., 230 Park Ave., New York, N. Y., has announced the opening of a sales office in the Russ Building, San Francisco. R. H. Binns, Jr., assistant sales manager of the Rome Division of Revere, will be in charge.

Wagner Electric Corp., 6463 Plymouth Ave., St. Louis, Mo., has issued a loose-leaf bulletin sheet, designated part 4B of Bulletin 172, devoted to air-cooled transformers. It describes Wagner types AC and AA units in sizes ranging from 1 to 50 kv-a, and voltages from 100 to 600.

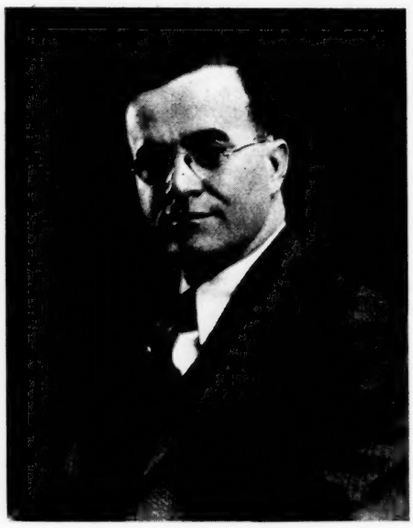
American Sheet and Tin Plate Co., Frick Building, Pittsburgh, has issued a 24-page booklet entitled "Steel Sheets, Applied to Modern Construction." Particular reference is made to heating, ventilating, and air conditioning systems. The booklet is illustrated with general views and details of sheet metal work in new buildings.

Owens-Illinois Glass Co., Toledo, Ohio, has issued a booklet entitled "Jobs to do at a Profit," which tells furnace installers how to do jobs at a profit by installing filters on gravity and mechanical furnaces.

Marsh Valve Co., Dunkirk, N. Y., has appointed Sarco Co., Inc., 183 Madison Ave., New York, as exclusive distributors in Greater New York of its entire line of valves for radiators and industrial purposes.

McIlvaine Burner Corp., Evanston, Ill., has appointed Lee Dygert, 42 North Division Ave., Grand Rapids, Mich., as its dealer for that territory.

General Electric Company's newly-created *Air Conditioning Department*, New York, has started commercial operations in 25 cities in the northeast. District sales representatives are selecting local business firms to market the new line of air conditioning and oil heating equipment. Franchises will be given to only one firm in each city. Cities in which operations have been started include Boston, Worcester, Springfield, New Bedford, Fall River, Providence, Hartford, New Haven, Bridgeport, Albany, Troy, Schenectady, Utica, Syracuse, Rochester, Jersey City, Newark, Trenton, Camden, Philadelphia, Baltimore, Washington, and New York.



J. J. Donovan, manager of General Electric's newly-created Air Conditioning Department

G. A. Bowman

Robertshaw Thermostat Co., Youngwood, Pa., has announced that G. A. Bowman has been appointed sales engineer covering the entire country, paying particular attention to the Company's line of gas boiler and furnace controls. Mr. Bowman formerly held a similar position with the Minneapolis-Honeywell Regulator Company.

Financial

Consolidated Gas Co., New York, reports for the three months ended March 31, steam sales of $4,319,676, as compared with $4,558,764 in 1931. Pounds of steam amounted to 4.6 billion, as compared with 4.8 billion. For the 12-month period ended March 31, operating revenue from steam was $9,364,466, as compared with $9,980,880.

Johns-Manville Corporation reports for the quarter ended on June 30 a consolidated net loss of $602,270, after expenses, depreciation and depletion. This contrasts with a net income of $715,657, equal to 78 cents a share on the 750,000 shares of common stock, after preferred dividend requirements, in the corresponding quarter of 1931. Sales for the period amounted to $5,129,625, against $9,618,774, a decrease of $4,489,149.

For the six months ended on June 30 the company had a consolidated net loss of $1,514,877, after all charges and reserves, contrasted with a net income of $945,767, or 91 cents a share on the common stock, in the first half of 1931. Sales for the first six months of this year totaled $9,733,816, against $17,430,261 last year, a decrease of $7,696,444.

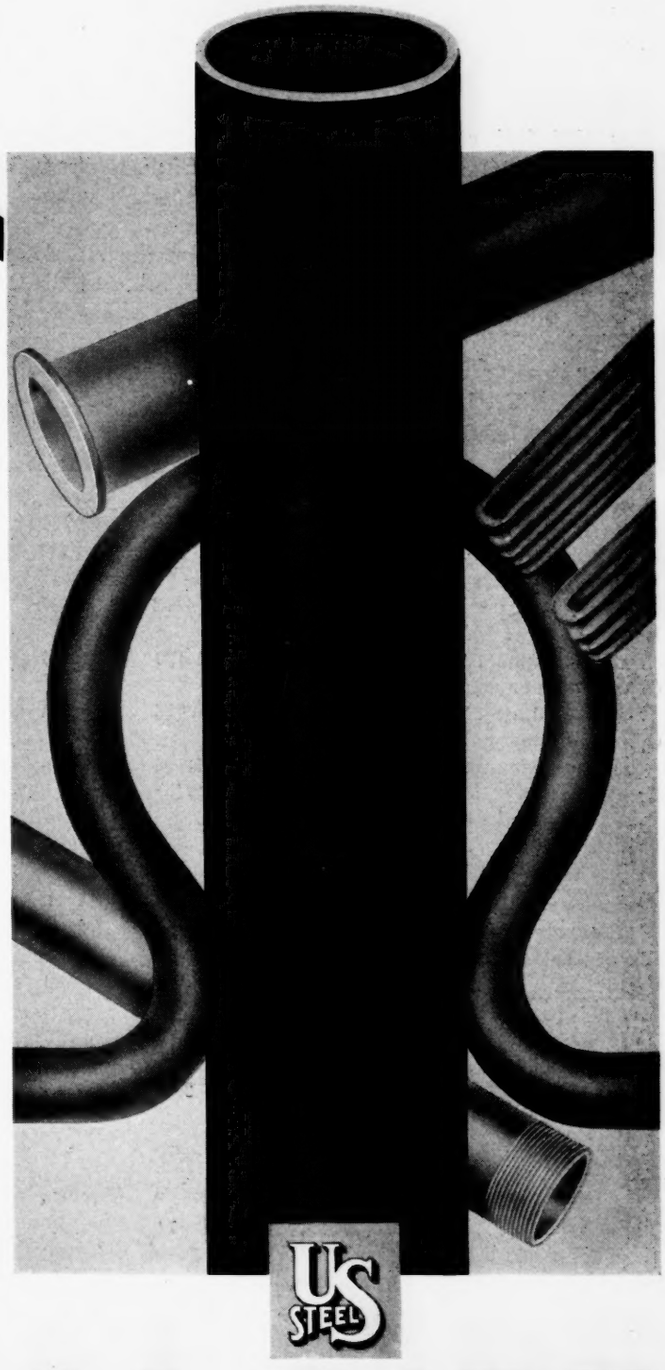
Minneapolis-Honeywell Regulator Company reports, for the twelve months ended June 30, net income after all charges, $639,070, equivalent after 6% preferred requirements to $2.69 a common share, contrasted with $184,167 deficit for corresponding period in 1931. Net sales, $5,082,310, against $1,637,301 in first half of last year.

STRENGTH

is only

ONE

of its advantages



IN any case where pressures, vibration, and varying temperatures must be endured by a piping system, strength is indispensable, of course; but strength is not all that is to be considered. Workability is likewise important, where the pipe must stand bending, flanging and coiling.

Corrosion resistance is of undeniable importance, for it will be the measure of strength or life of the pipe as time passes. Adaptability to any form of joint making is a highly desirable quality. A complete range of sizes and wall-thicknesses to meet a wide range of requirements is also of decided value, while the satisfaction that comes from the assurance that each and every length is uniform, thoroughly tested, has passed a rigid inspection and comforms to recognized standard specifications is an advantage that is too important to be overlooked in any piping job.

Experienced users of pipe everywhere recognize these advantages as inherent in NATIONAL Pipe —advantages that have made it—

America's Standard Wrought Pipe

NATIONAL TUBE COMPANY · Pittsburgh, Pa.
Subsidiary of United States Steel Corporation

US STEEL

NATIONAL PIPE

WELDED OR SEAMLESS

Degree Days and Unit Fuel Consumption in Typical Cities

June, 1932

UNIT fuel consumption figures given below must be corrected for efficiency, heat content of fuel other than that listed below, for radiation emitting other than 240 B.t.u. per hr., and for radiation calculated on a basis other than zero outside to 70° inside.

Coal is assumed as having a heat content of 12,000 B.t.u. per lb., gas, 1000 B.t.u. per cu. ft., and oil, 140,000 B.t.u. per gal. To correct for other heating values, multiply the fuel consumption listed under the charts by the standard heat content just listed, and divide by the heat content of the fuel actually being used in the installation being calculated.

For radiation installed for any other outside temperature than zero, multiply the fuel consumption given under the charts by 70°, divided by the quantity (70 minus the outside temperature used).

To correct for efficiency, divide the fuel consumption by the efficiency of the heating installation.

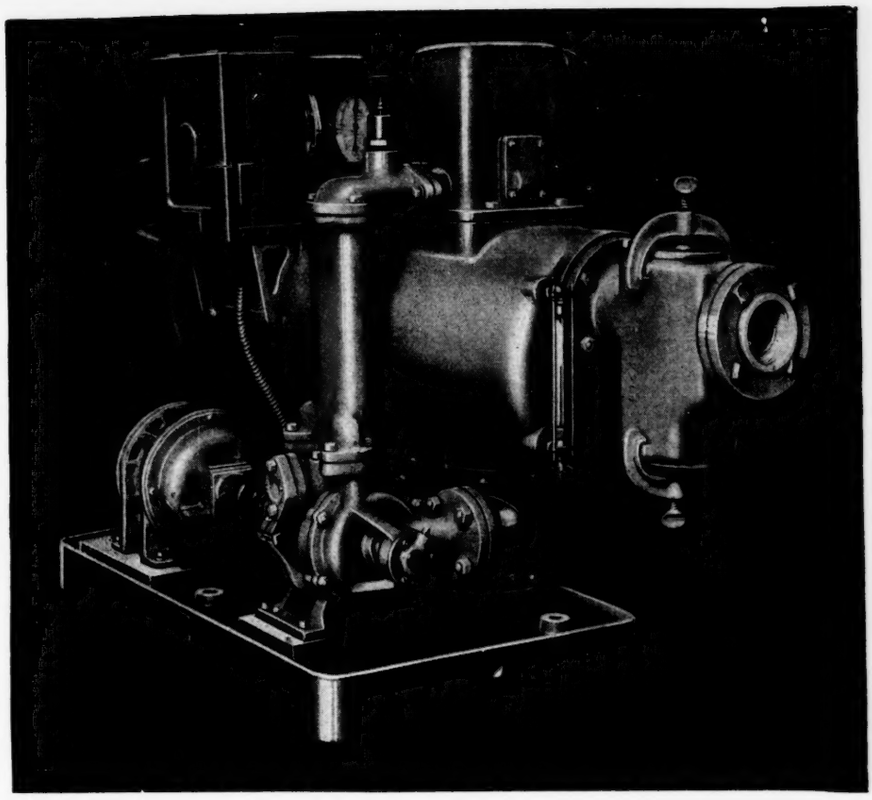
For water radiation, multiply the fuel consumption which is given for steam radiation by ⅝.

	New York	Seattle	San Francisco	Chicago	Denver	Boston	St. Louis	Pittsburgh	Minneapolis
Degree days	29	140	177	8	42	66	...	22	1
Total degree days heating season 1931-32	4443	4902	3071	5251	5648	5159	3581	4588	6944
Lb. of coal per sq. ft. of radiation for June	0.232	1.120	1.416	0.064	0.336	0.528	...	0.176	0.008
Gal. of oil per sq. ft. of radiation for June	0.020	0.096	0.121	0.005	0.029	0.045	...	0.015	0.001
Cu. ft. of gas per sq. ft. of radiation for June	2.78	13.44	16.99	0.77	4.032	6.34	...	2.11	0.10

	Los Angeles	Baltimore	Philadelphia	New Orleans	Atlanta	Cleveland	Cincinnati	Detroit
Degree days	28	5	8	...	...	17	3	17
Total degree days heating season 1931-32	1514	3484	3752	656	2165	5021	4079	5428
Lb. of coal per sq. ft. of radiation for June	0.224	0.040	0.064	...	...	0.136	0.024	0.136
Gal. of oil per sq. ft. of radiation for June	0.019	0.003	0.005	...	...	0.012	0.002	0.012
Cu. ft. of gas per sq. ft. of radiation for June	2.69	0.48	0.77	...	...	1.63	0.29	1.63

	Buffalo	Birmingham	Indianapolis	Memphis	Des Moines	Kansas City	Louisville	Galveston
Degree days	74	...	3	...	...	...	...	...
Total degree days heating season 1931-32	5963	1776	4459	2223	5595	4168	3521	845
Lb. of coal per sq. ft. of radiation for June	0.592	...	0.024	...	...	...	...	...
Gal. of oil per sq. ft. of radiation for June	0.051	...	0.002	...	...	...	...	...
Cu. ft. of gas per sq. ft. of radiation for June	7.104	...	0.29	...	...	...	...	...

Fuel consumption figures must be corrected for local conditions as explained above.



Jennings Vacuum Heating Pumps are furnished in capacities ranging from 4 to 400 g.p.m. of water and 3 to 171 cu. ft. per min. of air. Either automatically controlled or for continuous operation. For serving from 2,500 to 300,000 sq. ft. equivalent direct radiation.

Reserve capacity for the extra loads!

Starting up a return line heating system in the morning throws a heavy load on the vacuum heating pump. Steam condenses in the cold radiators faster than during the day. Large quantities of water that have collected over night must be removed.

Reserve capacity, more than sufficient to handle these extra loads, is built into every Jennings Vacuum Heating Pump. More—with each Jennings Pump, if desired, a certified test report is furnished which gives the exact number of g.p.m. of water and cu. ft. per min. of air that the pump delivered when tested under working conditions. No need to depend on published ratings which merely recommend a pump as suited to so many sq. ft. of radiation. You can be sure, when you install a Jennings, that it is the right pump for the job—that it will keep return lines and radiators always clear of air and condensation.

Bulletin 85 fully describes the construction and operation of the Jennings Vacuum Heating Pump. Write for a copy.

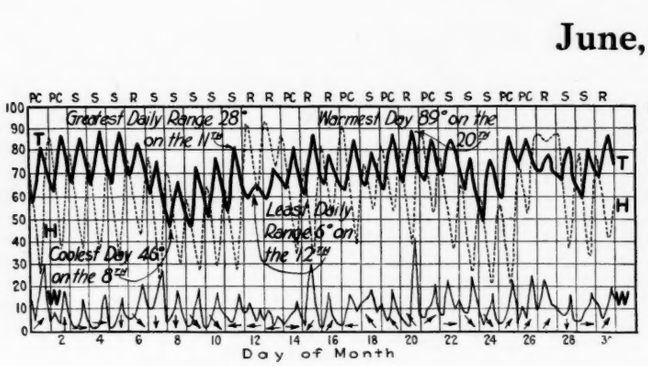
RETURN LINE AND AIR LINE VACUUM HEATING PUMPS—CONDENSATION PUMPS—COMPRESSORS AND VACUUM PUMPS FOR AIR AND GASES—STANDARD AND SUCTION CENTRIFUGAL PUMPS—HOUSE SERVICE PUMPS—SEWAGE EJECTORS—SUMP PUMPS—FLAT BOX PUMPS—MARINE PUMPS

Jennings Pumps

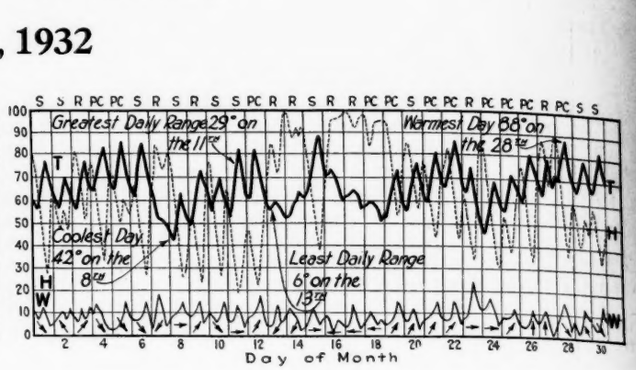
THE NASH ENGINEERING CO 81 WILSON ROAD, SOUTH NORWALK CONN.

The Weather

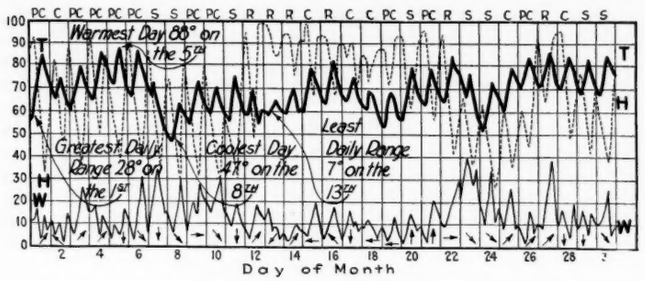
June, 1932


Greatest Daily Range 28° on the 11th
Warmest Day 89° on the 20th
Least Daily Range 6° on the 12th
Coolest Day 46° on the 8th
Day of Month

Pittsburgh

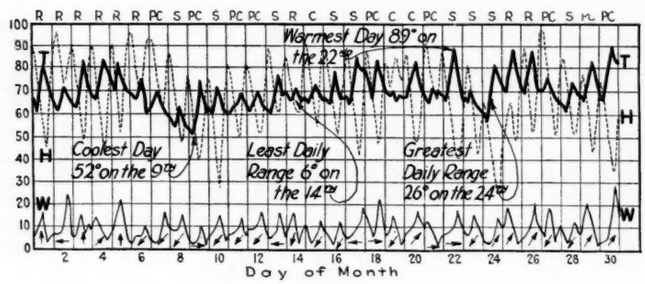

Greatest Daily Range 29° on the 11th
Warmest Day 86° on the 28th
Coolest Day 42° on the 8th
Least Daily Range 6° on the 13th
Day of Month

Boston

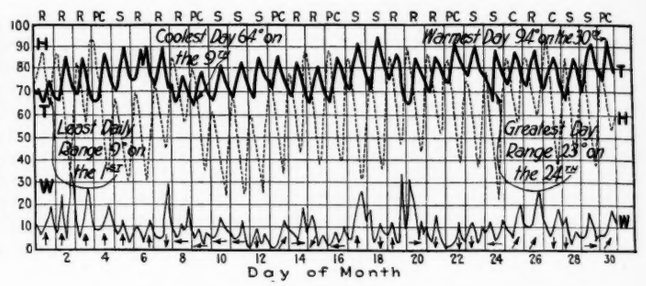

Warmest Day 88° on the 5th
Greatest Daily Range 28° on the 1st
Coolest Day 47° on the 8th
Least Daily Range 7° on the 13th
Day of Month

New York

(Hourly observation of the Relative Humidity Plotted on this Chart)


Warmest Day 89° on the 22nd
Coolest Day 52° on the 9th
Least Daily Range 6° on the 14th
Greatest Daily Range 26° on the 24th
Day of Month

Chicago


Coolest Day 64° on the 9th
Warmest Day 94° on the 30th
Least Daily Range 9° on the 1st
Greatest Day Range 23° on the 24th
Day of Month

St. Louis

	New York	Boston	Pittsburgh	Chicago	St. Louis
Highest temperature, deg. F.	88	88	89	89	94
Date of highest temperature	5	28	20	22	30
Lowest temperature, deg. F.	47	42	46	52	64
Date of lowest temperature	8	8	8	9	9
Greatest daily range, deg. F.	28	29	28	26	23
Date of greatest daily range	1	11	11	24	24
Least daily range, deg. F.	7	6	6	6	9
Date of least daily range	13	13	12	14	1
Mean temperature for month, deg. F.	69.0	66.4	71.0	70.6	77.6
Normal mean temperature for month, deg. F.	68.8	66.4	70.7	67.3	75.0
Total precipitation, this month, inches	3.57	2.05	0.78	4.79	2.45
Total snowfall, this month, inches	None	None	None	None	None
Normal precipitation, this month, inches	3.33	2.89	3.81	3.30	3.82
Total wind movement, this month, miles	8721	5546	6368	6042	6226
Average hourly wind velocity, miles	12.1	7.7	8.8	8.4	8.6
Prevailing direction of wind	S.W.	S.W.	W.	N.E.	S.
Number of clear days	8	7	2	8	10
Number of partly cloudy days	11	15	16	13	15
Number of cloudy days	11	8	12	9	5
Number of days with precipitation	7	11	8	12	13
Number of days with snowfall	None	None	None	None	None
Snow on ground, at end of month	None	None	None	None	None

Plotted from records especially compiled for HEATING AND VENTILATING by the United States Weather Bureau.
Heavy lines indicate temperatures in degrees F. Light lines indicate wind in miles per hour.
Broken lines indicate humidity in percentage from readings at 8 a. m., 12 m., and 8 p. m.
S—clear, PC—partly cloudy, C—cloudy, R—rain, Sn—snow. Arrows fly with prevailing directions of wind.

Heating and Ventilating

Only 6 elements to CONTROL ANY STEAM HEATING SYSTEM

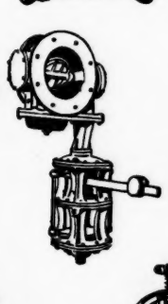
This **in each radiator** provides *equalized* and *balanced* distribution of steam throughout the system so that all radiators get heat at the same time and in substantially the same proportion regardless of distance from the boiler.

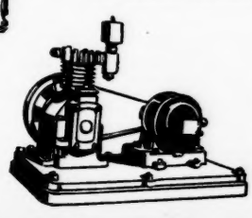
This **in each branch main** The exclusive Webster compound orifice method (patented) which proportions the steam for various sections of the system.

This **outdoors** automatically throttles the Main Control Valve so that it delivers sufficient steam for comfortable room temperatures as dictated by the prevailing outdoor air temperature.

This

in Superintendent's office, operating engineers room, or by PBX operator's switchboard, provides manual adjustment of steam from half to double normal requirements to meet unusual demands.

This  **in main serving all direct radiation** and recirculating units, regulates automatically the steam required to maintain comfortable room temperature under all conditions of weather.

This  **to supply power** to operate the entire control system.

UNIQUE in Comfort, Economy, and Simplicity, Webster Moderator Control continues to gain approval of architects, engineers and building owners. Following is a partial list of new and modernized installations—many in operation from one to five years:

Balto. City Hosp., Balto., Md.
Hutzler Bros. Store, Balto., Md.
Park Bank Bldg., Balto., Md.
St. Joseph's Convent, Campbellsport, Wisc.
Commonwealth Edison Service Bldg., Chicago, Ill.
Staley Administration Bldg., Decatur, Ill.
Hershey Hotel, Hershey, Pa.
Mech. Eng. Bldg. No. 2, Purdue Univ., Lafayette, Indiana
State Off. Bldg., Lansing, Mich.
Golden Rule Dept. Store, Minneapolis, Minn.
L. S. Donaldson Co.'s Store, Minneapolis, Minn.
Nurses Home, Univ. of Minn. Hospital, Minneapolis, Minn.
Hotel Dieu Hospital, Montreal
Holland-Plaza Building, N. Y.
Squibb Bldg., New York, N. Y.
1616 Walnut St., Phila., Pa.
Episcopal Hospital, Phila., Pa.
Integrity Building, Phila., Pa.
Missouri-Pacific Bldg., St. Louis, Mo.
Northern States Power Co. Off. Bldg., St. Paul, Minn.

WEBSTER MODERATOR CONTROL
"Control-by-the-weather"

A book describing Webster Moderator Control will be sent you upon request. Write Warren Webster & Co., Camden, N. J.